

CBSE | CUET | NEET | JEE

www.mtg.in
March 2023
Pages 100 | ₹ 75

PHYSICS

for you

India's #1
PHYSICS MONTHLY FOR
CBSE, CUET, NEET, JEE & OTHER PET EXAMS

PRACTICE PAPERS
JEE MAIN
NEET | CUET
WB JEE

2023: SOLVED PAPER
JEE MAIN
SESSION 1

BRUSH UP *for* **NEET/JEE**
Class XI-XII



mtg

Trust of more than
1 Crore Readers
Since 1982



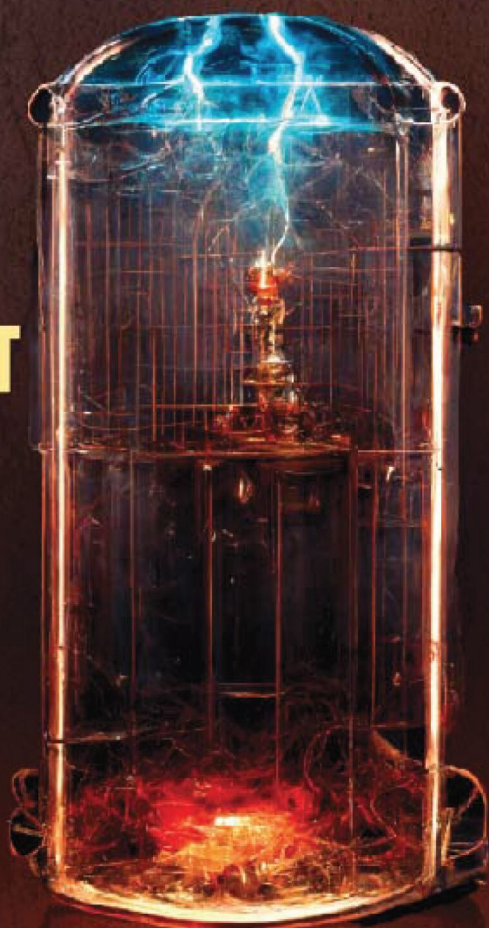
2023030013620

CBSE
warm up!

Class
XII

ARE YOU READY?
FOR NEET?

See inside page no. 47-54



VISIT...

LANZAROTE
Caliente.COM



SRM

INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University u/s 3 of UGC Act, 1956)

SRMJEEE B.Tech 2023

April | June | July

LEARNERS BECOMING LEADERS SRM - A BRAND TO RECKON WITH!

SRMIST is a uniquely large pioneering multi-disciplinary institution

GLOBAL RECOGNITION

2021



2023



One among 41
Indian Universities Ranked



NAAC A++
ACCREDITED



SHANGHAI
RANKING

One among 14 Universities
from India in ARWU2022-
Shanghai World University Rankings

2023



One among 75
Indian Universities
Ranked



RANKINGS 2022

University
19th Rank

nature index

Nature index ranking reflects SRMIST's
Research excellence and institutional performance.



Offers UG/PG/PhD Programs in Engineering and Technology
Management | Science and Humanities | Law
Medicine & Health Sciences | Agricultural Sciences

www.srmist.edu.in

Helpline : 080 690 87000

Email : admissions.india@srmist.edu.in



Disclaimer : *The content available in MTG digital/physical books is intellectual property of MTG Learning Media Pvt Ltd. Paid content on this website after purchase is not entitled for free distribution on whatsapp, telegram, twitter, facebook, and all other social media and digital channels. The registered owner/admin/ individual of any digital channel will be liable for an infringement of the copyright for illegally using the material / copyrighted content of MTG Learning Media Pvt Ltd.*



NITTE
HAS SOMETHING
FOR EVERYONE!

QS ASIA
UNIVERSITY
RANKING 2023
451-500 BAND

NIRF 2022
UNIVERSITY
RANKING
75

NAAC
ACCREDITATION
A+ GRADE

PROGRAMS OFFERED

Engineering | Medicine | Dentistry | Architecture | Pharmacy | Nursing
Physiotherapy | Biomedical Science | Speech & Hearing | Allied Health
Communication | Public Health | Management | Hospitality Management
Fashion Technology | Interior Design | Hospital Administration



6th Floor, Medical Sciences Complex, Deralakatte, Mangaluru - 575 018

☎ +91 95131 88844 | 81472 07324 | 🌐 www.nitte.edu.in | ✉ info@nitte.edu.in | [f](#) [t](#) [v](#) [i](#)

How to choose the right answer, fast?

Visit www.mtg.in for latest offers and to buy online!

₹ 850 ₹ 850 ₹ 850 ₹ 999

The answer is practice...

Our team has seen that in NEET and JEE, Multiple Choice Questions (MCQs) are based on the NCERT syllabus. Largely !! With Objective NCERT at your FINGERTIPS, you can become a pro at handling MCQs. Practice to increase your accuracy and improve timing with a bank of approx. 15,000 questions, all framed from NCERT course books. Don't take our word, have a look what some of our readers / toppers have to say...

Features:

- NCERT NEET/JEE Trend Indicator
- NCERT Notes with HD Pages
- NCERT Based Topicwise MCQs
- NCERT Exemplar Problems MCQs
- NCERT Exam Scorer : A & R, Case Based & NV Type Questions, HOTS
- NCERT Based Exam Archive Questions
- Practice Papers & Model Test Papers

Tanishka Yadav, "I have used MTG NCERT Fingertips and Biology Today magazine. They provided me additional information that proved to be very useful in NEET preparation. MCQs given in the MTG NCERT Fingertips gave me a fair idea of what to expect in the exam."

Nalin Khandelwal, "MTG NCERT at Your Fingertips-Biology and MTG 31 Years NEET- AIPMT Chapterwise Solutions helped me a lot in my preparation. My advice for future aspirants would be to be thorough with NCERT by doing multiple readings till all the concepts in all subjects are clear. Also, solving previous years' papers is very helpful."

Bhavik Bansal, "I have followed MTG NCERT at Your Fingertips, AIIMS Explorer Assertion and Reason books and magazines Physics For You, Biology Today and Chemistry Today. I used to solve questions from CBSE Drill and NEET Ready from MTG Magazines."

Kalpna Kumari, "I have followed MTG NCERT at Your Fingertips, Assertion and Reason books and magazines Physics For You, Biology Today and Chemistry Today. In my opinion, full dedication and smartly planning your preparation are the most important components of an ideal preparation."

Mrinal Dewangan, "MTG Objective NCERT at your Fingertips is a great book and Explorers provided very accurate question papers similar to those asked in exams, which helped me a lot during preparation."

Het Shah, "For MCQs I referred to 'MTG Objective NCERT at your Fingertips' which is an exceptional book in itself. Also I referred to all the MTG Books for previous years' question papers of different exams."



Scan now with your smartphone or tablet

Application to read QR codes required



MTG Learning Media (P) Ltd.
Plot #99, Sector 44, Gurugram - 122 003 (HR)

Available at all leading book shops throughout India.

For more information or for help in placing your order,
Call 0124-6601200 or e-mail: info@mtg.in



KALINGA INSTITUTE OF INDUSTRIAL TECHNOLOGY (KIIT)

Deemed to be University

(Established U/S 3 of UGC Act, 1956), Bhubaneswar, Odisha, India

25 Silver Jubilee
Years 1997-2022
SOIL TO SILVER

20th
Among Indian Universities
Ranked by NIRF - 2021
nirf

Rank **1**

MHRD
ATRIAL
ATRIAL RANKING OF INSTITUTIONS
FOR EMPLOYMENT ACQUISITION
Among Self-Financing Institutes of India

Tier 1
Accreditation
Washington Accord
NBA

A++
NAAC

ABET
ABET (US)
Accreditation

IE The Institution of
Engineering and Technology

KIITEE
2023
APPLY ONLINE
NOW

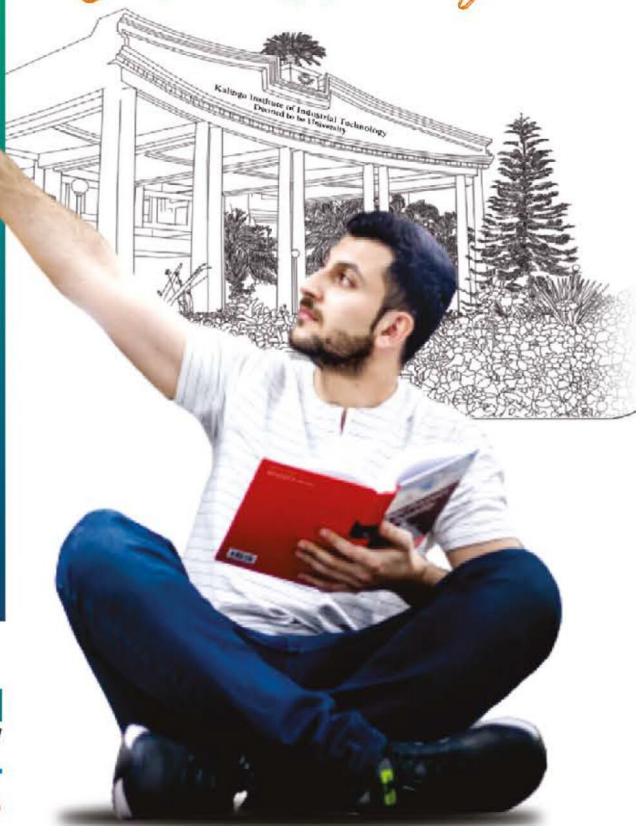
Through KIIT Websites

www.kiitee.ac.in

www.kiit.ac.in

No Application / Examination Fee,
Computer Based Online Test

Continuous learning



ENGINEERING
COMPUTER APPLICATION
ARCHITECTURE **LAW**
SOCIAL, FINANCIAL **MANAGEMENT**
& HUMAN SCIENCES **RURAL MANAGEMENT**
LANGUAGE **AGRIBUSINESS**
MANAGEMENT **MASS**
BIOTECHNOLOGY **COMMUNICATION**
CHEMICAL TECHNOLOGY **PUBLIC**
FASHION **FILM** **HEALTH**
TECHNOLOGY & MEDIA SCIENCES
SPIRITUALISM & APPLIED SCIENCES
YOGIC SCIENCES **NURSING SCIENCES**

THE
WORLD UNIVERSITY
RANKINGS

World University Rankings 2023

301-400

Computer
Science

401-500

Engineering

601-800

University
Ranking

CAMPUS PLACEMENT 2022 HIGHLIGHTS



750 +
companies



6000 +
job offers



95%
students
already placed



₹52 Lakhs
highest CTC
offered*



2000+
paid internship
opportunities

Director, Admissions : Admission Cell, Koel Campus, Po- KIIT,
Bhubaneswar-751024, Odisha, India,

Ph: 8080 735 735, Fax : 0674 - 2741465, Email : admission@kiit.ac.in



Google play

KIIT (Deemed to be University) has only one permanent campus in Bhubaneswar, Odisha.
It has no other campus / off campus anywhere else in the country and globe.

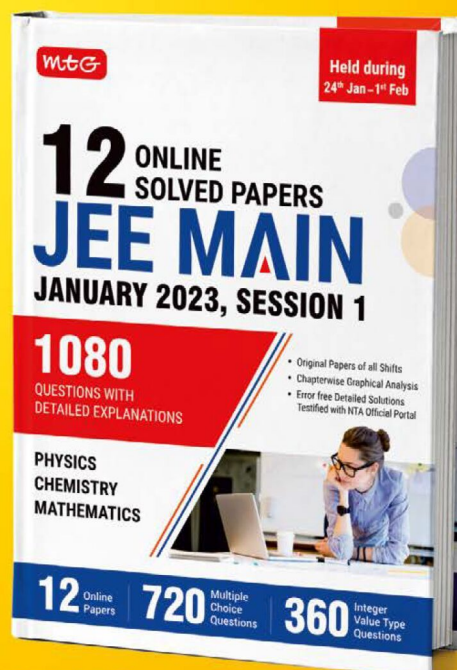
Last Minute Check on Your JEE Readiness

12 ONLINE SOLVED PAPERS JEE MAIN JANUARY 2023 SESSION 1

This book includes **12 Online Papers** conducted by **NTA** as per the latest pattern of JEE Main (MCQs + Numerical Value Type Questions)

Chapterwise tabular and Graphical analysis showing the weightage of chapters

Error Free Detailed Solutions
Testified with NTA Official website



₹ 300/-

PHYSICS for you

VOLUME 31

No. 3

March 2023

Managing Editor
Mahabir Singh

Editor
Anil Ahlawat

Corporate Office:

Plot 99, Sector 44 Institutional area, Gurugram - 122 003 (HR).
Tel : 0124-6601200 e-mail : info@mtg.in website : www.mtg.in

Regd. Office:

406, Taj Apartment, Near Safdarjung Hospital, New Delhi - 110029.

Contents

Competition Edge

JEE Main Solved Paper 2023 **9**
(Session-1, 24th Jan, Morning Shift)

JEE Main Practice Paper 2023 **16**

NEET Practice Paper 2023 **22**

CUET (UG) Chapterwise Practice Paper 2023 **34**
Modern Physics

Word Grid **42**

Unique Career in Demand **43**

GK Corner **44**

Are You Ready for NEET? **47**

Quiz Club **55**

WB JEE Practice Paper 2023 **56**

Class 11

Brush Up for NEET / JEE **65**
*Heat and Thermodynamics / Kinetic Theory of Gases /
Oscillations / Waves*

Monthly Test Drive **72**
Laws of Motion

Class 12

Brush Up for NEET / JEE **76**
*Semiconductor Electronics :
Materials, Devices and Simple Circuits*

CBSE Warm Up **82**
Practice Paper

Monthly Test Drive **90**
Current Electricity

Subscribe online at www.mtg.in

SUBSCRIPTION PLAN				
Subject	Format	1 Year	2 Years	3 Years
Individual - Physics - Mathematics - Chemistry - Biology	Print issue	₹749/-	₹1349/-	₹1799/-
	Print + Digital	₹1150/-	₹1850/-	₹2400/-
Combo of 3 Magazines - Physics, Chemistry, Biology - Physics, Chemistry, Mathematics	Print issue	₹2200/-	₹4000/-	₹5400/-
	Print + Digital	₹3000/-	₹5000/-	₹6600/-
Combo of 4 Magazines Physics, Chemistry, Mathematics, Biology	Print issue	₹2800/-	₹5200/-	₹6300/-
	Print + Digital	₹3800/-	₹6399/-	₹7800/-
Courier Charges Add to your subscription amount for quicker & traceable delivery		₹800/-	₹960/-	₹1440/-

Send D.D/M.O in favour of MTG Learning Media (P) Ltd.
Payments should be made directly to : MTG Learning Media (P) Ltd,
Plot No. 99, Sector 44, Gurugram - 122003 (Haryana)
We have not appointed any subscription agent.

Printed and Published by Mahabir Singh on behalf of MTG Learning Media Pvt. Ltd. Printed at HT Media Ltd., B-2, Sector-63, Noida, UP-201307 and published at 406, Taj Apartment, Ring Road, Near Safdarjung Hospital, New Delhi - 110029.
Editor : Anil Ahlawat

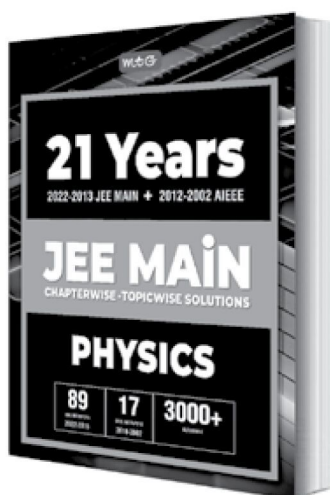
Readers are advised to make appropriate thorough enquiries before acting upon any advertisement published in this magazine. Focus/ Infocus features are marketing incentives. MTG does not vouch or subscribe to the claims and representations made by advertisers. All disputes are subject to Delhi jurisdiction only.

Copyright© MTG Learning Media (P) Ltd.

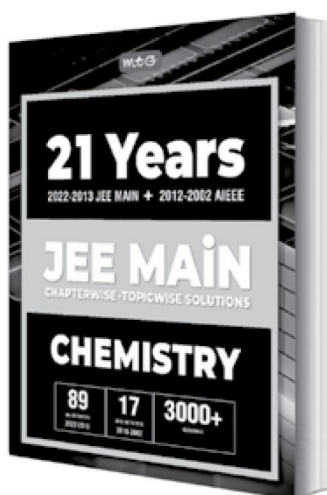
All rights reserved. Reproduction in any form is prohibited.

The Best tool for success in JEE Main

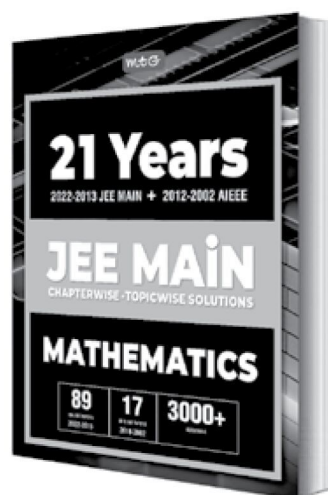
21 Years' JEE Main Chapterwise-Topicwise Solutions Physics, Chemistry and Mathematics contain not only chapterwise - topicwise questions that have appeared over the last 21 years in JEE Main / AIEEE but also their complete solutions. Needless to say these books are essential for any student to compete successfully in JEE Main.



₹ 800/-



₹ 800/-



₹ 800/-

HIGHLIGHTS:

- Chapterwise-Topicwise Questions (Online & Offline) of last 21 years' (2002-2022) of JEE Main / AIEEE
- Chapterwise-Topicwise segregation of questions to help you assess the level of effort required to succeed
- An unmatched series with more than 1740 pages filled with detailed solutions by experts

Visit
www.mtg.in
for latest offers
and to buy
online!



MTG Learning Media (P) Ltd.
Plot #99, Sector 44, Gurugram - 122 003 (HR)

Available at all leading book shops throughout India.
For more information or for help in placing your order,
Call 0124-6601200 or e-mail: info@mtg.in



Scan to explore & buy more
JEE Books on mtg.in

JEE MAIN 2023

SECTION-A (MULTIPLE CHOICE QUESTIONS)

1. Given below are two statements : ONE is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) : Photodiodes are preferably operated in reverse bias condition for light intensity measurement.

Reason (R) : The current in the forward bias is more than the current in the reverse bias for a $p-n$ junction diode.

In the light of the above statements, choose the correct answer from the options given below.

- (a) (A) is true but (R) is false.
(b) Both (A) and (R) are true and (R) is the correct explanation of (A).
(c) (A) is false but (R) is true.
(d) Both (A) and (R) are true but (R) is NOT the correct explanation of (A).

2. A travelling wave is described by the equation

$$y(x, t) = [0.05 \sin(8x - 4t)] \text{ m}$$

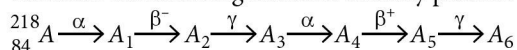
The velocity of the wave is

[All the quantities are in SI units.]

- (a) 4 m s^{-1} (b) 8 m s^{-1}
(c) 0.5 m s^{-1} (d) 2 m s^{-1}
3. Two long straight wires P and Q carrying equal current 10 A each were kept parallel to each other at 5 cm distance. Magnitude of magnetic force experienced by 10 cm length of wire P is F_1 . If distance between wires is halved and currents on them are doubled, force F_2 on 10 cm length of wire P will be

- (a) $10 F_1$ (b) $8 F_1$ (c) $\frac{F_1}{8}$ (d) $\frac{F_1}{10}$

4. Consider the following radioactive decay process.



The mass number and the atomic number of A_6 are give by

- (a) 211 and 80 (b) 210 and 80
(c) 210 and 82 (d) 210 and 84

5. From the photoelectric effect experiment, following observations are made. Identify which of these are correct.

- A. The stopping potential depends only on the work function of the metal.
B. The saturation current increases as the intensity of incident light increases.
C. The maximum kinetic energy of a photo electron depends on the intensity of the incident light.
D. Photoelectric effect can be explained using wave theory of light.

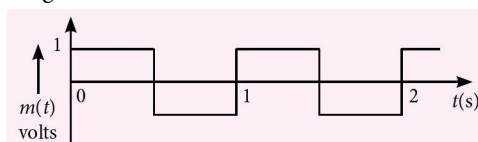
Choose the correct answer from the options given below.

- (a) A, B, D only (b) B only
(c) A, C, D only (d) B, C only

6. 1 g of a liquid is converted to vapour at $3 \times 10^5 \text{ Pa}$ pressure. If 10% of the heat supplied is used for increasing the volume by 1600 cm^3 during this phase change, then the increase in internal energy in the process will be

- (a) 4800 J (b) 4320 J
(c) $4.32 \times 10^8 \text{ J}$ (d) 432000 J

7. A modulating signal is a square wave, as shown in the figure.



If the carrier wave is given as $c(t) = 2 \sin(8\pi t)$ volts, the modulation index is

- (a) $\frac{1}{3}$ (b) 1 (c) $\frac{1}{2}$ (d) $\frac{1}{4}$

8. Given below are two statements.

Statement I : The temperature of a gas is -73°C . When the gas is heated to 527°C , the root mean square speed of the molecules is doubled.

Statement II : The product of pressure and volume of an ideal gas will be equal to translational kinetic energy of the molecules.

In the light of the above statements, choose the correct answer from the options given below.

- (a) Statement I is false but statement II is true.
 (b) Both statement I and statement II are true.
 (c) Both statement I and statement II are false.
 (d) Statement I is true but statement II is false.
9. If $\vec{E}$ and $\vec{K}$ represent electric field and propagation vectors of the EM waves in vacuum, then magnetic field vector is given by (ω -angular frequency)
- (a) $\frac{1}{\omega}(\vec{K} \times \vec{E})$ (b) $\omega(\vec{K} \times \vec{E})$
 (c) $\vec{K} \times \vec{E}$ (d) $\omega(\vec{E} \times \vec{K})$

10. A circular loop of radius r is carrying current I A. The ratio of magnetic field at the center of circular loop and at a distance r from the center of the loop on its axis is

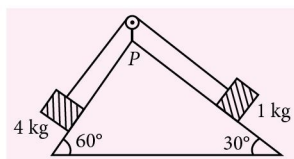
- (a) $1:3\sqrt{2}$ (b) $2\sqrt{2}:1$ (c) $3\sqrt{2}:2$ (d) $1:\sqrt{2}$

11. A 100 m long wire having cross-section area $6.25 \times 10^{-4} \text{ m}^2$ and Young's modulus is 10^{10} N m^{-2} is subjected to a load of 250 N, then the elongation in the wire will be

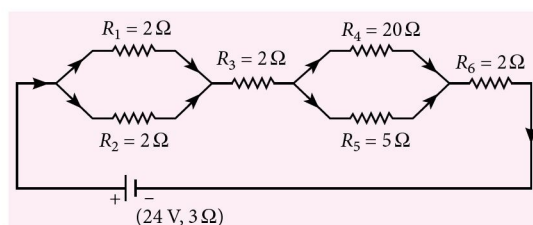
- (a) $6.25 \times 10^{-3} \text{ m}$ (b) $4 \times 10^{-3} \text{ m}$
 (c) $4 \times 10^{-4} \text{ m}$ (d) $6.25 \times 10^{-6} \text{ m}$

12. As per given figure, a weightless pulley P is attached on a double inclined frictionless surfaces. The tension in the string (massless) will be (if $g = 10 \text{ m/s}^2$)

- (a) $(4\sqrt{3} - 1) \text{ N}$
 (b) $4(\sqrt{3} - 1) \text{ N}$
 (c) $(4\sqrt{3} + 1) \text{ N}$
 (d) $4(\sqrt{3} + 1) \text{ N}$



13. As shown in the figure, a network of resistors is connected to a battery of 24 V with an internal resistance of 3Ω . The currents through the resistors R_4 and R_5 are I_4 and I_5 respectively. The values of I_4 and I_5 are



- (a) $I_4 = \frac{8}{5} \text{ A}$ and $I_5 = \frac{2}{5} \text{ A}$
 (b) $I_4 = \frac{6}{5} \text{ A}$ and $I_5 = \frac{24}{5} \text{ A}$
 (c) $I_4 = \frac{2}{5} \text{ A}$ and $I_5 = \frac{8}{5} \text{ A}$
 (d) $I_4 = \frac{24}{5} \text{ A}$ and $I_5 = \frac{6}{5} \text{ A}$

14. Match List I with List II.

List-I		List-II	
(A)	Planck's constant (h)	(I)	$[\text{M}^1\text{L}^2\text{T}^{-2}]$
(B)	Stopping potential (V_s)	(II)	$[\text{M}^1\text{L}^1\text{T}^{-1}]$
(C)	Work function (ϕ)	(III)	$[\text{M}^1\text{L}^2\text{T}^{-1}]$
(D)	Momentum (p)	(IV)	$[\text{M}^1\text{L}^2\text{T}^{-3}\text{A}^{-1}]$

Choose the correct answer from the options given below.

- (a) (A) $\rightarrow$ (II), (B) $\rightarrow$ (IV), (C) $\rightarrow$ (III), (D) $\rightarrow$ (I)
 (b) (A) $\rightarrow$ (III), (B) $\rightarrow$ (IV), (C) $\rightarrow$ (I), (D) $\rightarrow$ (II)
 (c) (A) $\rightarrow$ (I), (B) $\rightarrow$ (III), (C) $\rightarrow$ (IV), (D) $\rightarrow$ (II)
 (d) (A) $\rightarrow$ (III), (B) $\rightarrow$ (I), (C) $\rightarrow$ (II), (D) $\rightarrow$ (IV)

15. Given below are two statements.

Statement I : An elevator can go up or down with uniform speed when its weight is balanced with the tension of its cable.

Statement II : Force exerted by the floor of an elevator on the foot of a person standing on it is more than his/her weight when the elevator goes down with increasing speed.

In the light of the above statements, choose the correct answer from the options given below.

- (a) Statement I is false but statement II is true.
 (b) Statement I is true but statement II is false.
 (c) Both statement I and statement II are false.
 (d) Both statement I and statement II are true.

16. The weight of a body at the surface of earth is 18 N. The weight of the body at an altitude of 3200 km above the earth's surface is (given radius of earth $R_e = 6400 \text{ km}$)

- (a) 19.6 N (b) 9.8 N (c) 4.9 N (d) 8 N

17. A conducting circular loop of radius $\frac{10}{\sqrt{\pi}}$ cm is placed perpendicular to a uniform magnetic field of 0.5 T. The magnetic field is decreased to zero in 0.5 s at a steady rate. The induced emf in the circular loop at 0.25 s is

(a) emf = 1 mV (b) emf = 100 mV
(c) emf = 5 mV (d) emf = 10 mV

18. Given below are two statements.

Statement I : If the Brewster's angle for the light propagating from air to glass is θ_B , then the Brewster's angle for the light propagating from glass to air is $\frac{\pi}{2} - \theta_B$.

Statement II : The Brewster's angle for the light propagating from glass to air is $\tan^{-1}(\mu_g)$ where μ_g is the refractive index of glass.

In the light of the above statements, choose the correct answer from the options given below.

(a) Both statement I and statement II are true.
(b) Both statement I and statement II are false.
(c) Statement I is true but statement II is false.
(d) Statement I is false but statement II is true.

19. The maximum vertical height to which a man can throw a ball is 136 m. The maximum horizontal distance upto which he can throw the same ball is
(a) 68 m (b) 136 m (c) 192 m (d) 272 m

20. If two charges q_1 and q_2 are separated with distance 'd' and placed in a medium of dielectric constant k . What will be the equivalent distance between charges in air for the same electrostatic force?
(a) $k\sqrt{d}$ (b) $1.5d\sqrt{k}$ (c) $2d\sqrt{k}$ (d) $d\sqrt{k}$

SECTION - B (NUMERICAL VALUE TYPE)

Attempt any 5 questions out of 10.

21. A hole is drilled in a metal sheet. At 27°C , the diameter of hole is 5 cm. When the sheet is heated to 177°C , the change in the diameter of hole is $d \times 10^{-3}$ cm. The value of d will be _____ if coefficient of linear expansion of the metal is $1.6 \times 10^{-5} \text{ }^\circ\text{C}^{-1}$.
22. A spherical body of mass 2 kg starting from rest acquires a kinetic energy of 10000 J at the end of 5th second. The force acted on the body is _____ N.
23. A hollow cylindrical conductor has length of 3.14 m, while its inner and outer diameters are 4 mm and 8 mm respectively. The resistance of

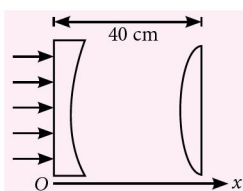
the conductor is $n \times 10^{-3} \Omega$. If the resistivity of the material is $2.4 \times 10^{-8} \Omega \text{ m}$. The value of n is _____.

24. Assume that protons and neutrons have equal masses. Mass of a nucleon is $1.6 \times 10^{-27} \text{ kg}$ and radius of nucleus is $1.5 \times 10^{-15} A^{1/3} \text{ m}$. The approximate ratio of the nuclear density and water density is $n \times 10^{13}$. The value of n is _____.

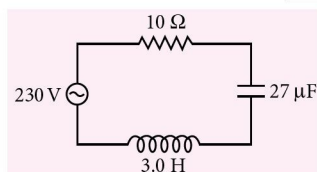
25. Vectors $a\hat{i} + b\hat{j} + \hat{k}$ and $2\hat{i} - 3\hat{j} + 4\hat{k}$ are perpendicular to each other when $3a + 2b = 7$, the ratio of a to b is $x/2$. The value of x is _____.

26. As shown in the figure, a combination of a thin plano concave lens and a thin plano convex lens is used to image an object placed at infinity. The radius of curvature of both the lenses is 30 cm and refractive index of the material for both the lenses is 1.75.

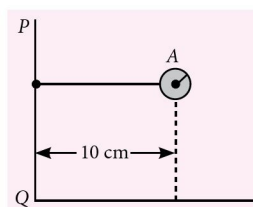
Both the lenses are placed at distance of 40 cm from each other. Due to the combination, the image of the object is formed at distance $x = \text{_____ cm}$, from concave lens.



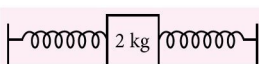
27. A stream of a positively charged particles having $\frac{q}{m} = 2 \times 10^{11} \text{ C kg}^{-1}$ and velocity $\vec{v}_0 = 3 \times 10^7 \hat{i} \text{ m s}^{-1}$ is deflected by an electric field $1.8 \hat{j} \text{ kV m}^{-1}$. The electric field exists in a region of 10 cm along x direction. Due to the electric field, the deflection of the charge particles in the y direction is _____ mm.
28. In the circuit shown in the figure, the ratio of the quality factor and the band-width is _____ s.



29. Solid sphere A is rotating about an axis PQ. If the radius of the sphere is 5 cm, then its radius of gyration about PQ will be $\sqrt{x}$ cm. The value of x is _____.



30. A block of a mass 2 kg is attached with two identical springs of spring constant 20 N m^{-1} each. The block is placed on a frictionless surface and the ends of the springs are attached to rigid supports (see figure). When the mass is displaced from its equilibrium position, it executes a simple harmonic motion. The time period of oscillation is $\frac{\pi}{\sqrt{x}}$ in SI unit. The value of x is _____.



SOLUTIONS

1. (d): When a p - n junction diode is forward biased, the width of depletion region decreases. Although when the diode is reverse biased the width of depletion region increases. Due to this increased width the incident light gets more surface area and more number of electrons can be emitted. This will lead to more photocurrent.

Also, we know that the current in forward biased p - n junction is more than the current in reverse biased p - n junction.

2. (c): Given, $y(x, t) = [0.05 \sin(8x - 4t)] \text{ m}$
Comparing with standard equation
 $y(x, t) = a \sin(kx - \omega t)$; $k = 8$; $\omega = 4$

$$\therefore \text{Velocity, } v = \frac{\omega}{k} = \frac{4}{8} = 0.5 \text{ m s}^{-1}$$

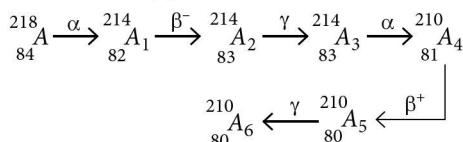
3. (b): Magnetic force between two parallel current carrying wires is $\frac{F}{l} = \frac{\mu_0}{2\pi d} I_1 I_2$

$$\text{Given, } F_1 = \left(\frac{\mu_0}{2\pi d} I_1 I_2 \right) (l)$$

$$\text{Similarly, } F_2 = \frac{\mu_0}{2\pi(d/2)} (2I_1)(2I_2)(l)$$

$$\therefore \frac{F_1}{F_2} = \frac{1}{2 \times 2 \times 2} = \frac{1}{8} \Rightarrow F_2 = 8F_1$$

4. (b): The decay process is as below



Thus mass number and the atomic number of A_6 will be 210 and 80 respectively.

5. (b): The stopping potential (V_0) depends upon frequency, as well as work function, as $eV_0 = h\nu - \phi_0$.

As the intensity of light increases, the saturation current increases.

The maximum kinetic energy of emitted electron is independent of intensity of incident light.

Photoelectric effect explains the particle nature of light.

6. (b): We know that,
 $\Delta W = P\Delta V = 3 \times 10^5 \times 1600 \times 10^{-6} = 480 \text{ J}$
According to the question, only 10% of heat is used in work done, so
 $\therefore \Delta Q = 4800 \text{ J}$
The remaining 90% of ΔQ will be used to change internal energy.

$$\therefore \Delta U = (90\%) \text{ of } \Delta Q = \frac{90}{100} \times 4800 = 4320 \text{ J}$$

7. (c): From the given diagram, $A_m = 1 \text{ V}$
Also, $A_c = 2 \text{ V}$

$$\therefore \text{Modulation index, } \mu = \frac{A_m}{A_c} = \frac{1}{2}$$

8. (d): We know that, $v_{rms} \propto \sqrt{T}$

$$\therefore \frac{v_{rms2}}{v_{rms1}} = \sqrt{\frac{T_2}{T_1}} = \sqrt{\frac{273+527}{-(73)+273}} = \sqrt{\frac{800}{200}} = \sqrt{4} = 2$$

$$\therefore v_{rms2} = 2v_{rms1}$$

Also, we know that $PV = \frac{2}{3} K$, where K is translational kinetic energy.

9. (a): Here, the magnetic field vector will be along $\hat{K} \times \vec{E}$.

$$\text{Also, } |\vec{B}| = \frac{|\vec{E}|}{C} \Rightarrow \vec{B} = \left(\frac{E}{C} \right) \hat{K} \times \vec{E}$$

$$= \frac{\hat{K} \times \vec{E}}{C} = \frac{\hat{K} \times \vec{E}}{\omega / K} \quad \left[\because C = \frac{\omega}{K} \right]$$

$$= \frac{K \hat{K} \times \vec{E}}{\omega} = \frac{\vec{K} \times \vec{E}}{\omega} \quad (\because K \hat{K} = \vec{K})$$

10. (b): Magnetic field on the axis of the loop is given

$$\text{by, } B = \frac{\mu_0 I r^2}{2(r^2 + x^2)^{3/2}}$$

Here, r = radius of the loop

x = distance from the centre.

$$\text{At the centre ; } x = 0; B = \frac{\mu_0 I}{2r}$$

$$\text{At, } x = r; B' = \frac{\mu_0 I r^2}{2(r^2 + r^2)^{3/2}} = \frac{\mu_0 I r^2}{2(2r^2)^{3/2}}$$

$$= \frac{\mu_0 I r^2}{2(2)^{3/2} r^3} = \frac{\mu_0 I}{(2r)(2^{3/2})}$$

$$\therefore \frac{B}{B'} = 2^{3/2} = \sqrt{8} = 2\sqrt{2} : 1$$

11. (b): Given, $A = 6.25 \times 10^{-4} \text{ m}^2$, $Y = 10^{10} \text{ N m}^{-2}$
 $F = 250 \text{ N}$

$$\text{As, } Y = \frac{F/A}{\Delta L/L} = \frac{250}{6.25 \times 10^{-4}} \times \frac{L}{\Delta L}$$

$$\Rightarrow 10^{10} = \frac{250}{6.25 \times 10^{-4}} \times \frac{100}{\Delta L} \quad \therefore \Delta L = 4 \times 10^{-3} \text{ m}$$

12. (d): Acceleration of the blocks is given by

$$a = \frac{m_1 g \sin \theta_1 - m_2 g \sin \theta_2}{m_1 + m_2}$$

Here, $m_1 = 4 \text{ kg}$, $m_2 = 1 \text{ kg}$, $\theta_1 = 60^\circ$, $\theta_2 = 30^\circ$

$$\therefore a = \frac{(4 \times \sin 60^\circ - 1 \times \sin 30^\circ) g}{4 + 1}$$

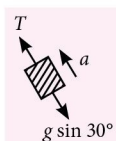
$$\therefore a = \frac{g \left(4 \times \frac{\sqrt{3}}{2} - \frac{1}{2} \right)}{5} ; a = (4\sqrt{3} - 1) \text{ m s}^{-2}$$

Now, for 1 kg block, $T - g \sin 30^\circ = a$

$$\text{As, } a = (4\sqrt{3} - 1) \text{ m/s}^2$$

$$T = g \sin 30^\circ + 4\sqrt{3} - 1$$

$$= 5 + 4\sqrt{3} - 1 = 4 + 4\sqrt{3} = 4(\sqrt{3} + 1) \text{ N}$$



13. (c): Total current in the circuit is given by,

$$I = \frac{E}{R+r} = \frac{24}{R+3}$$

R = Total resistance of the circuit

From the given circuit we can calculate R ,

$$= \frac{2 \times 2}{2+2} + 2 + \frac{20 \times 5}{20+5} + 2 = 1 + 2 + 4 + 2 = 9 \Omega$$

$$\therefore I = \frac{24}{9+3} = 2 \text{ A}$$

$$\text{Also, } I_4 + I_5 = I \Rightarrow I_4 + I_5 = 2 \quad \dots(i)$$

$$\text{Also, } I_4 R_4 = I_5 R_5$$

$$\Rightarrow I_4 \times 20 = I_5 \times 5 \Rightarrow \frac{I_4}{I_5} = \frac{1}{4} \Rightarrow I_5 = 4I_4 \quad \dots(ii)$$

From (i) and (ii)

$$I_4 + 4I_4 = 2 \Rightarrow I_4 = \frac{2}{5} \text{ A} \quad \therefore I_5 = 4I_4 = \frac{8}{5} \text{ A}$$

14. (b): We know that $E = h\nu \Rightarrow [E] = [h][\nu]$

$$\Rightarrow [h] = \frac{[E]}{[\nu]} = \frac{[\text{ML}^2\text{T}^{-2}]}{[1/\text{T}]} = [\text{ML}^2\text{T}^{-1}]$$

$$\text{Potential} = \frac{W}{Q} \Rightarrow [V] = \frac{[W]}{[Q]} = \frac{[\text{ML}^2\text{T}^{-2}]}{[\text{AT}]}$$

$$= [\text{ML}^2\text{T}^{-3}\text{A}^{-1}]$$

Work function will have same dimension as energy.

$$\therefore [\phi] = [E] = [\text{ML}^2\text{T}^{-2}]$$

Momentum, $p = mv$

$$[p] = [m][v] = \text{MLT}^{-1}$$

Thus correct answer is option (b).

(A) $\rightarrow$ (III), (B) $\rightarrow$ (IV), (C) $\rightarrow$ (I), (D) $\rightarrow$ (II)

15. (b): When the elevator is going up with acceleration a , the apparent weight is given by $W' = m(g + a)$
 Similarly when going down, $W' = m(g - a)$
 $\Rightarrow W' < W$

Also, weight of the elevator is balanced by the tension in the cable.

16. (d): Weight of the body at an altitude h is given by

$$W = mg' = \frac{mg}{\left(1 + \frac{h}{R}\right)^2} = \frac{W_s}{\left(1 + \frac{h}{R}\right)^2}$$

$$= \frac{18}{\left(1 + \frac{3200}{6400}\right)^2} = \frac{18}{\left(1 + \frac{1}{2}\right)^2} = \frac{18 \times 4}{9} = 8 \text{ N}$$



ONLINE TEST SERIES

Practice Part Syllabus/ Full Syllabus
24 Mock Tests for

JEE Main



Now on your android smart phones
with the same login of web portal.

Log on to test.pcmbody.com

17. (d): Given, $R = \frac{10}{\sqrt{\pi}} \text{ cm} = \frac{10}{\sqrt{\pi}} \times 10^{-2} \text{ m}$; $B = 0.5 \text{ T}$,

Here magnetic field is decreasing at steady rate

$$\therefore \frac{\Delta B}{\Delta t} = -\frac{0.5-0}{0.5} = -1 \text{ T/s}$$

$$\therefore \text{Induced emf, } e = -\frac{\Delta \Phi}{\Delta t} = -A \frac{\Delta B}{\Delta t} = -A(-1) = A$$

$$e = \pi R^2 = \pi \times \left(\frac{10 \times 10^{-2}}{\sqrt{\pi}} \right)^2 = 10^{-2} \text{ V}$$

$$\therefore e = 10 \text{ mV}$$

18. (c): Consider propagation of light is from air to glass.

$$\text{Here, } 1 \times \sin i_B = \mu_g \sin r \quad (\because i_B = \theta_B)$$

$$\Rightarrow \sin \theta_B = \mu_g \sin (90^\circ - \theta_B) \\ = \mu_g \cos \theta_B$$

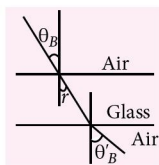
$$\Rightarrow \tan \theta_B = \mu_g$$

Similarly, when light goes from glass to air,

$$\Rightarrow \mu_g \sin \theta'_B = 1 \times \sin (90^\circ - \theta'_B)$$

$$\tan \theta'_B = 1/\mu_g = \cot \theta_B = \tan (90^\circ - \theta_B)$$

$$\Rightarrow \theta'_B = 90^\circ - \theta_B$$



19. (d): Maximum vertical height up to which a person can throw the ball is $H = \frac{u^2}{2g} \sin^2 \theta = 136 \text{ m}$

$$\Rightarrow H_{\max} = \frac{u^2}{2g} = 136 \text{ m} \quad \dots(i)$$

Where, u = initial speed, θ = angle of projection

$$\text{Also, maximum horizontal distance } R = \frac{u^2 \sin 2\theta}{g} \\ \Rightarrow R_{\max} = \frac{u^2}{g} \quad \dots(ii)$$

From (i) and (ii), we get

$$R_{\max} = 2 H_{\max} = 2 \times 136 = 272 \text{ m}$$

20. (d): Force between two charges in the medium

$$F_m = \frac{1}{4\pi\epsilon_0 k} \frac{q_1 q_2}{d^2} = \frac{1}{4\pi}$$

$$\text{Force in the air is } F_a = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{d_0^2}$$

$$\text{Given, } F_m = F_a \Rightarrow \frac{1}{4\pi\epsilon_0 k} \frac{q_1 q_2}{d^2}$$

$$\text{Force in the air is } F_a = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{d_0^2}$$

$$\text{Given, } F_m = F_a; \frac{1}{4\pi\epsilon_0 k} \frac{q_1 q_2}{d^2} = \frac{q_1 q_2}{4\pi\epsilon_0 k d_0^2}$$

$$\Rightarrow d_0^2 = kd^2 \Rightarrow d_0 = \sqrt{k}d$$

21. (12): The increase in area of the hole is given by

$$A = A_0 (1 + \beta \Delta T), \text{ where } A_0 = \text{area at } 27^\circ \text{C}$$

A = area at 177°C , β = coefficient of area expansion

$$\Rightarrow \frac{A - A_0}{A_0} = \beta \Delta T \Rightarrow \frac{r^2 - r_0^2}{r_0^2} = \beta \Delta T$$

$$\Rightarrow \left(\frac{r}{r_0} \right)^2 - 1 = \beta \Delta T \Rightarrow \left(\frac{r}{r_0} \right)^2 = 1 + \beta \Delta T$$

$$\Rightarrow \frac{r}{r_0} = (1 + \beta \Delta T)^{1/2} = 1 + \frac{1}{2} \beta \Delta T \quad (\because \beta \ll 1)$$

$$\Rightarrow \frac{r - r_0}{r_0} = \frac{1}{2} \beta \Delta T \Rightarrow \frac{d_1 - d_0}{d_0} = \frac{1}{2} \beta \Delta T$$

where d_1 and d_0 are corresponding diameters.

$$\Rightarrow \frac{\Delta d}{d_0} = \frac{\beta \Delta T}{2} \Rightarrow \Delta d = \frac{1}{2} (\beta) (177 - 27) d_0$$

$$= \left(\frac{2\alpha}{2} \right) (150)(5) \text{ cm} = 750 \times \alpha \text{ cm}$$

$$= 750 \times 1.6 \times 10^{-5} \text{ cm} = 1200 \times 10^{-5} \text{ cm} = 12 \times 10^{-3} \text{ cm}$$

$$\therefore d = 12$$

22. (40): From work-energy theorem, $\Delta W = \Delta K$

$$\Rightarrow \frac{1}{2} m v^2 = 10000 \Rightarrow \frac{1}{2} \times 2 \times v^2 = 10000$$

$$\Rightarrow v = 100 \text{ m/s} \Rightarrow at = 100$$

$$\Rightarrow \frac{F}{m} t = 100 \Rightarrow F = \frac{m}{t} \times 100$$

$$\Rightarrow F = \frac{2}{5} \times 100 = 40 \text{ N}$$

23. (2): Resistance of the hollow cylindrical conductor

$$\text{is given by, } R = \rho \frac{l}{\pi(r_2^2 - r_1^2)}$$

where r_2 = outer radius, r_1 = inner radius

ρ = resistivity, l = length

$$\therefore \rho = \frac{2.4 \times 10^{-8} \times 3.14}{\pi \left(\frac{8^2}{4} - \frac{4^2}{4} \right) \times 10^{-6}} \\ = \frac{2.4 \times 10^{-8} \times 4}{48 \times 10^{-6}} = 2 \times 10^{-3} \Omega$$

24. (11): Density of a nucleus is

$$\rho = \frac{\text{Mass of nucleus}}{\text{Volume of nucleus}} = \frac{1.6 \times 10^{-27}}{\frac{4}{3} \pi (1.5 \times 10^{-15})^3 \text{ A}}$$

$$= \frac{1.6 \times 10^{-27}}{14.14 \times 10^{-45}} = 0.113 \times 10^{18} \text{ kg/m}^3$$

As density of water, $\rho_w = 10^3 \text{ kg/m}^3$

$$\therefore \frac{\rho}{\rho_w} = \frac{0.113 \times 10^{18}}{10^3} \quad \therefore \frac{\rho}{\rho_w} \approx 11 \times 10^{13}$$

25. (1) : Let $\vec{p} = a\hat{i} + b\hat{j} + \hat{k}$, $\vec{q} = 2\hat{i} - 3\hat{j} + 4\hat{k}$

Given, $\vec{p} \perp \vec{q}$

$$\Rightarrow \vec{p} \cdot \vec{q} = 0 \Rightarrow p_x q_x + p_y q_y + p_z q_z = 0$$

$$\Rightarrow a \times 2 + b(-3) + 1 \times 4 = 0$$

$$\Rightarrow 2a - 3b + 4 = 0$$

It is given, $3a + 2b = 7$

$$\Rightarrow a = \frac{7-2b}{3}$$

From eqn (i) and (ii)

$$2\left[\frac{7-2b}{3}\right] - 3b + 4 = 0 \Rightarrow b = 2$$

$$\Rightarrow a = \frac{7-2b}{3} = \frac{7-4}{3} = 1 \Rightarrow \frac{a}{b} = \frac{1}{2} \Rightarrow x = 1$$

26. (120) : Focal length of the plano concave lens is

$$\frac{1}{f} = (\mu - 1) \left(\frac{1}{\infty} - \frac{1}{R} \right)$$

$$= (1.75 - 1) \left(0 - \frac{1}{30} \right) = \left(\frac{3}{4} \right) \left(-\frac{1}{30} \right) \Rightarrow f = -40 \text{ cm.}$$

Focal length of the plano convex lens is

$$\frac{1}{f} = (\mu - 1) \left(\frac{1}{R} - \frac{1}{\infty} \right) = (1.75 - 1) \left(\frac{1}{R} \right) = \left(\frac{3}{4} \right) \left(\frac{1}{30} \right)$$

$$\Rightarrow f = 40 \text{ cm}$$

Image formed by the plano concave lens will be at the focus i.e., at -40 cm from the first lens. This image will act as object for the second lens.

The object will be at 80 cm (2f) from second lens. Thus final image will be formed at (80 + 40) cm from the concave lens.

27. (2) : Given, $\frac{q}{m} = 2 \times 10^{11} \text{ C/kg}$

$$\vec{v}_0 = (3 \times 10^7 \hat{i}) \text{ m/s}; \vec{E} = (1.8 \hat{j}) \text{ kV/m}$$

Deflection along y-direction is given by,

$$y = \frac{1}{2} a_y t^2 = \frac{1}{2} \left(\frac{qE}{m} \right) t^2$$

$$\text{Also, } 10 \text{ cm} = v_0 t \Rightarrow 10 \times 10^{-2} = 3 \times 10^7 \times t$$

$$\Rightarrow t = \frac{10 \times 10^{-2}}{3 \times 10^7} = \frac{1}{3} \times 10^{-8} \text{ s}$$

$$\therefore y = \frac{1}{2} (2 \times 10^{11}) \times 1.8 \times 10^3 \times \frac{1}{9} \times 10^{-16}$$

$$\Rightarrow y = 10^{-3} \times 2 = 2 \text{ mm}$$

28. (10) : Quality factor of the LCR circuit is

$$Q = \frac{X_L}{R} = \frac{\omega_r L}{R}$$

$$\text{Bandwidth, } BW = \frac{\omega_r}{Q} = \frac{1/\sqrt{LC}}{\frac{1}{R}\sqrt{\frac{L}{C}}} = R/L$$

$$\therefore \frac{Q}{BW} = \frac{\omega_r L/R}{R/L} = \frac{L}{R} \times \omega_r \times \frac{L}{R} = \frac{L^2}{R^2} \times \frac{1}{\sqrt{LC}}$$

$$= \frac{9}{100} \times \frac{1}{\sqrt{27 \times 10^{-6} \times 3}} = 10\text{s}$$

29. (110) : Moment of inertia of the sphere about the given axis is, $I = I_0 + Md^2$

$$= \frac{2}{5} MR^2 + M(10)^2 = \left[\frac{2}{5} \times (5)^2 + (10)^2 \right] M$$

$$\text{Also, } I = MK^2 \Rightarrow K^2 = \frac{2}{5} \times (5)^2 + (10)^2$$

On comparing with given values, we get,

$$\Rightarrow k = \sqrt{110} \text{ cm}$$

30. (5) : The given two springs are connected in parallel.

Equivalent spring constant is given by

$$K_{eq} = K_1 + K_2 = 20 + 20 = 40 \text{ N/m}$$

Mass of the block, $m = 2 \text{ kg}$,

$\therefore$ Time period,

$$T = 2\pi \sqrt{\frac{m}{K_{eq}}} = 2\pi \sqrt{\frac{2}{40}} = 2\pi \sqrt{\frac{1}{20}} = \pi \sqrt{\frac{4}{20}} = \frac{\pi}{\sqrt{5}}$$

On comparing with given values, we get

$$\therefore x = 5$$



SOLUTIONS TO FEBRUARY 2023 QUIZ CLUB

- | | |
|---|---|
| 1. False | 10. Nuclear fusion |
| 2. Surface tension of water decreases when we add some detergent into it. | 11. High resistance bulb |
| 3. True | 12. Convex lens |
| 4. When object is in uniform circular motion, speed remains constant. | 13. Reflection of sound |
| 5. North-East | 14. Magnetic equator |
| 6. Perfectly elastic collision | 15. 931.5 MeV |
| 7. Zero Kelvin | 16. Boyle's law |
| 8. Remains same | 17. Infinite |
| 9. A shows amplitude and B shows wavelength. | 18. Minimum force = 25 N |
| | 19. For constructive interference
$I_{\max} = I_1 + I_2$ |
| | 20. Red |

Winner: Piyush Jain (M.P)

PRACTICE PAPER 2023 JEE MAIN

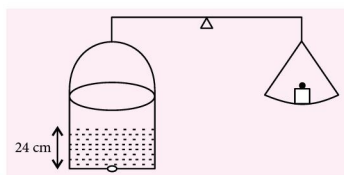
Exam Dates

Session-2

06, 08, 10, 11, 12
April 2023

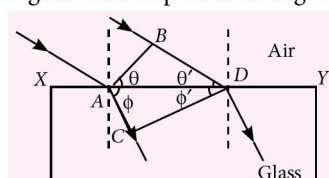
SECTION-A (MULTIPLE CHOICE QUESTIONS)

- The length of a given cylindrical wire is increased by 100%. Due to the consequent decrease in diameter the change in the resistance of the wire will be
(a) 200 % (b) 100 % (c) 50 % (d) 300 %.
- If the mass of a planet is 10% less than that of the Earth and the radius 20% greater than that of the Earth, the acceleration due to gravity on the planet will be
(a) $\frac{5}{8}$ times that on the surface of the Earth
(b) $\frac{3}{4}$ times that on the surface of the Earth
(c) $\frac{1}{2}$ times that on the surface of the Earth
(d) $\frac{9}{10}$ that on the surface of the Earth
- A circular current carrying coil has a radius R . The distance from the centre of the coil on the axis, where the magnetic induction will be $\left(\frac{1}{8}\right)^{\text{th}}$ to its value at the centre of the coil is
(a) $\frac{R}{\sqrt{3}}$ (b) $R\sqrt{3}$ (c) $2\sqrt{3}R$ (d) $\frac{2}{\sqrt{3}}R$
- A cylinder containing water up to a height of 24 cm has a hole in its bottom. It is counterpoised in a balance. When water begins to flow out, the initial decrease in balancing weight is required to be 12g f to keep the 'balance beam' horizontal. The cross-sectional area of the hole is

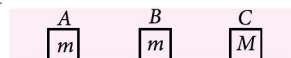


- (a) 0.12 cm^2 (b) 0.25 cm^2
(c) 0.50 cm^2 (d) 0.75 cm^2

- A wavefront AB moving in air is incident on a plane glass surface XY , as given in figure. Its position CD after refraction through a glass slab is shown along with normals drawn at A and D . The refractive index of glass with respect to air is given by



- (a) $\frac{\sin \theta}{\sin \theta'}$ (b) $\frac{\sin \phi}{\sin \theta}$ (c) $\frac{\sin \theta}{\sin \phi'}$ (d) $\frac{AB}{CD}$
- Three blocks A, B and C are lying on a smooth horizontal surface, as shown in the figure. A and B have equal masses, m while C has mass M . Block A is given an initial speed v towards B due to which it collides with B perfectly inelastically. The combined mass collides with C, also perfectly inelastically $5/6^{\text{th}}$ of the initial kinetic energy is lost in whole process. What is value of M/m ?



- (a) 5 (b) 2 (c) 3 (d) 4
- In the Millikan's Oil drop experiment an oil drop carries four electronic charges and has a mass of $1.8 \times 10^{-12} \text{ g}$. It is held almost at rest between two horizontal charged plates 1.8 cm apart. What voltage must there be between the two charged plates?
(a) 500 V (b) 496 V (c) 510 V (d) 450 V
 - A simple pendulum is set up on a trolley which slides down a frictionless inclined plane making an angle θ with horizontal. The time period of pendulum is equals

- (a) $2\pi\sqrt{\frac{l}{g}}$ (b) $2\pi\sqrt{\frac{l \cos \theta}{g}}$
(c) $2\pi\sqrt{\frac{l}{g \cos \theta}}$ (d) $2\pi\sqrt{\frac{l}{g(1 - \cos \theta)}}$

9. At $t = 0$, an inductor of zero resistance is joined to a cell of emf E through a resistance. The current increases with a time constant τ . The emf across the coil after time t is

(a) $Ee^{t/\tau}$ (b) $Ee^{-t/\tau}$
(c) $Ee^{-2t/\tau}$ (d) $E(1 - e^{-t/\tau})$

10. The engine of a boat drives it across a river that is 1800 m wide. The velocity $\vec{v}_{BW}$ of boat relative to the water is 4 m/s directed perpendicular to the current, as in the figure. Given $\vec{v}_{WS} = 2$ m/s.

What is the velocity $\vec{v}_{BS}$ of the boat relative to the shore?

(a) 4.5 m/s and 63° (b) 4.5 m/s and 72°
(c) 2.9 m/s and 37° (d) 2.9 m/s and 22°

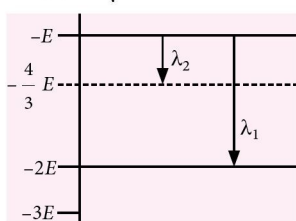
11. Six charges each equal to $+Q$ are placed at the corners of a regular hexagon of each side x . What is the electric field at the intersection of its diagonals?

(a) $\frac{1}{4\pi\epsilon_0} \frac{36Q}{x^2}$ (b) $\frac{1}{4\pi\epsilon_0} \frac{6Q}{x^2}$
(c) $\frac{1}{4\pi\epsilon_0} \frac{Q}{x^2}$ (d) zero

12. A road runs mid-way between two parallel rows of building. A motorist moving with a velocity of 36 km h^{-1} sounds the horn. He hears the echo 1 sound after he has sounded the horn. If velocity of sound is 330 m s^{-1} , then the distance between the two rows of building is

(a) $2\sqrt{165^2 - 5^2} \text{ m}$ (b) $\sqrt{165^2 - 5^2} \text{ m}$
(c) $\sqrt{330^2 - 10^2} \text{ m}$ (d) $2\sqrt{330^2 - 10^2} \text{ m}$

13. Some energy levels of a molecule are shown in the figure. The ratio of the wavelengths $\frac{\lambda_1}{\lambda_2}$ is given by



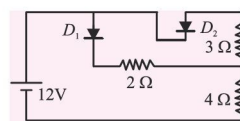
(a) $r = \frac{4}{3}$ (b) $r = \frac{2}{3}$ (c) $r = \frac{3}{4}$ (d) $r = \frac{1}{3}$

14. Match the C_p/C_v ratio for ideal gases with different type of molecules.

Molecule type	C_p/C_v
(A) Monatomic	(I) 7/5
(B) Diatomic rigid molecules	(II) 9/7
(C) Diatomic non-rigid molecules	(III) 4/3
(D) Triatomic rigid molecules	(IV) 5/3

(a) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)
(b) (A)-(IV), (B)-(II), (C)-(I), (D)-(III)
(c) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)
(d) (A)-(IV), (B)-(I), (C)-(II), (D)-(III)

15. In the circuit of figure treat the diodes as ideal. Current in the 4 ohm resistor is



(a) 2 A (b) 3 A
(c) $12/7$ A (d) $30/13$ A

16. This question contains Statement-1 and Statement-2. Of the four choices given after the statements, choose the one that best describes the two statements.

Statement-1: For a charged particle moving from point P to point Q , the net work done by an electrostatic field on the particle is independent of the path connecting point P to point Q .

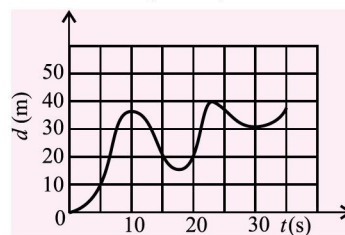
Statement-2: The net work done by a conservative force on an object moving along a closed loop is zero.

(a) Statement-1 is true, Statement-2 is false
(b) Statement-1 is true, Statement-2 is true; Statement-2 is the correct explanation of Statement-1.
(c) Statement-1 is true, Statement-2 is true; Statement-2 is not the correct explanation of Statement-1.
(d) Statement-1 is false, Statement-2 is true.

17. Two long, thin wires distant d apart exert a force F on one another when current through each wire is I . The distance between the wires is doubled and the current is decreased to $I/3$. The force they exert on one another now is

(a) $F/6$ (b) $F/9$ (c) $2F/3$ (d) $F/18$

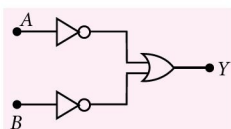
18. In the displacement d versus time t graph given below, the value of average velocity in the time interval 0 to 20 s is (in m/s).



(a) 1.5 (b) 4 (c) 1 (d) 2

19. Name the gate represented by the combination of gates as shown in figure.

- (a) OR
(b) AND
(c) NAND
(d) NOR



20. **Assertion :** A change in the temperature of a body causes change in its dimensions.

Reason : The dimensions of a body decrease due to the increase in its temperature.

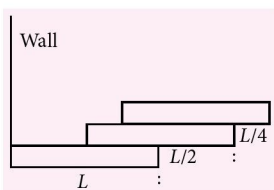
- (a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

SECTION-B (NUMERICAL TYPE QUESTIONS)

Attempt any 5 questions out of 10.

21. A TV tower has a height of 75 m. What is the maximum distance (in km) upto which this TV transmission can be received? ($R = 6400$ km)

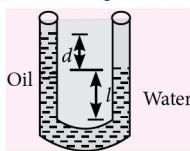
22. Three bricks each of length L and mass M are arranged as shown from the wall. The distance of the centre of mass of the system from the wall



is $\frac{x}{12}L$, then what will be the value of x ?

23. The coil in a tangent galvanometer is 16 cm in radius. How many turns of the wire should be wound on it if a current of 20 mA is to produce a deflection of 45° ? Take horizontal component of earth's field $= 0.36 \times 10^{-4}$ T.

24. The U-tube contains two liquids as shown in static equilibrium. Water of density $\rho_w (= 998 \text{ kg m}^{-3})$ is in the right arm and the oil of unknown density ρ_x is in the left. Measurement gives $l = 135$ mm and $d = 12.3$ mm. What is the density (in kg/m^3) of the oil?



25. The electric field intensity produced by the radiation coming from a 100 W bulb at a distance of 3 m is E . The electric field intensity produced

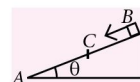
by the radiation coming from 60 W at the same

distance is $\sqrt{\frac{x}{5}}E$, what will be the value of x ?

26. A cup of coffee cools from 50°C to 45°C in 5 minutes and to 40°C in another 8 minutes. Find the temperature (in $^\circ\text{C}$) of the surroundings.

27. Two radioactive materials A and B have decay constants 25λ and 16λ respectively. If initially they have the same number of nuclei, then the ratio of the number of nuclei of B to that of A will be " e " after a time $1/a\lambda$. What will be the value of a ?

28. A small block starts slipping down from a point B on an inclined plane AB, which is making an angle θ with the horizontal section BC is smooth and the remaining section CA is rough with a coefficient of friction μ . It is found that the block comes to rest as it reaches the bottom (point A) of the inclined plane. If $BC = 2AC$, the coefficient of friction is given by $\mu = k \tan\theta$. What will be the value of k ?



29. Let a total charge $2Q$ be distributed in a sphere of radius R , with the charge density given by $\rho(r) = kr$, where r is the distance from the centre. Two charges A and B, of $-Q$ each, are placed on diametrically opposite points, at equal distance, a , from the centre. If A and B do not experience any force, then the value of a is $R \times n^{-\frac{1}{4}}$. Find n .

30. Critical angle for certain medium is $\sin^{-1}(0.6)$. The polarizing angle of that medium is $\tan^{-1}(x)$, then what will be the value of x ?

SOLUTIONS

1. (d): Let the length of the wire be l , radius of the wire be r

$\therefore$ Resistance $R = \rho \frac{l}{\pi r^2}$ where ρ = resistivity of the wire

Now l is increased by 100% $\therefore l' = l + \frac{100}{100}l = 2l$

As length is increased, its radius is going to be decreased in such a way that the volume of the cylinder remains constant.

$$\pi r^2 \times l = \pi r'^2 \times l' \Rightarrow r'^2 = \frac{r^2 \times l}{l'} = \frac{r^2 \times l}{2l} = \frac{r^2}{2}$$

$\therefore$ The new resistance

$$R'^2 = \rho \frac{l'}{\pi r'^2} = \rho \frac{2l}{\pi \times \frac{r^2}{2}} = 4R$$

∴ Change in resistance = $R' - R = 3R$

$$\therefore \% \text{ change} = \frac{3R}{R} \times 100\% = 300\%$$

2. (a): $g = \frac{GM}{R^2}; g' = \frac{G\left(\frac{90}{100}M\right)}{\left(\frac{120}{100}R\right)^2} = \left(\frac{0.9}{1.2^2}\right) \frac{GM}{R^2} = \frac{5}{8}g$

3. (b)

4. (b): $v = \sqrt{2gh}, \frac{dm}{dt} = \rho Av$

$$\text{Thrust} = \frac{dm}{vdt} = \rho Av^2 = \rho A(2gh)$$

$$\text{Here, } \rho A \cdot 2gh = 12 \text{ gram} \times 980 \text{ cm/s}^2$$

$$\left(\frac{1 \text{ gm}}{\text{cc}}\right) \cdot (A) \cdot 2 \left(\frac{980 \text{ cm}}{\text{s}^2}\right) \cdot 24 \text{ cm} = 12 \text{ gm} \times \frac{980 \text{ cm}}{\text{s}^2}$$

$$\Rightarrow A = \frac{12}{24 \times 2} = 0.25 \text{ cm}^2$$

5. (c): The angle of incidence, $i = \theta$ and the angle of refraction, $r = \phi'$

$$\text{According to Snell's law, } \frac{\sin i}{\sin r} = \mu = \frac{\sin \theta}{\sin \phi'}$$

6. (d): $K_i = \frac{1}{2}mv^2$

Using conservation of linear momentum,

$$mv = (2m + M)v_1 \Rightarrow v_1 = \frac{mv}{(2m + M)}$$

$$\text{Also, } K_f = \frac{1}{6}K_i \text{ or } \frac{1}{2}(2m + M)v_1^2 = \frac{1}{6}\left(\frac{1}{2}mv^2\right)$$

$$\text{or } (2m + M) \times \frac{m^2 v^2}{(2m + M)^2} = \frac{1}{6}mv^2 \Rightarrow \frac{M}{m} = 4$$

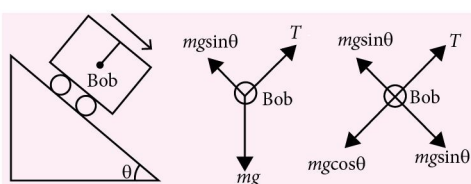
7. (b): As, $E = \frac{V}{d}$ and $qE = mg$

$$\Rightarrow \frac{qV}{d} = mg \text{ or } V = \frac{mg \cdot d}{q}$$

$$\frac{(1.8 \times 10^{-12} \times 10^{-3} \text{ kg}) \left(\frac{9.8 \text{ m}}{\text{s}^2}\right) (1.8 \times 10^{-2} \text{ m})}{(4 \times 1.6 \times 10^{-19} \text{ C})}$$

$$= 496 \text{ V}$$

8. (c):



At equilibrium, inside the trolley, Tension = $mg \cos \theta$
Hence effective $g' = g \cos \theta$

$$T = 2\pi \sqrt{\frac{l}{g'}} = 2\pi \sqrt{\frac{l}{g \cos \theta}}$$

9. (b): $i = \frac{E}{R} \left(1 - e^{-\frac{t}{\tau}}\right)$

$$\text{Emf across coil} = \frac{L di}{dt} = L \left[\frac{E}{R} \left(\frac{1}{\tau}\right) \right] e^{-\frac{t}{\tau}}$$

$$\text{Now } \tau = \frac{L}{R} \Rightarrow \text{Emf across coil} = E e^{-\frac{t}{\tau}}$$

10. (a): $\vec{v}_{BS} = \vec{v}_{BW} + \vec{v}_{WS}$

As $\vec{v}_{BW}$ is normal

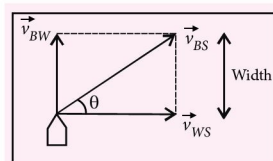
to $\vec{v}_{WS}$, using

Pythagoras theorem,

$$v_{BS} = \sqrt{v_{BW}^2 + v_{WS}^2} = \sqrt{(4.0 \text{ m/s})^2 + (2.0 \text{ m/s})^2} \approx 4.5 \text{ m/s}$$

The direction of the boat relative to the shore,

$$\tan \theta = \frac{v_{BW}}{v_{WS}} = \left(\frac{4.0 \text{ m/s}}{2.0 \text{ m/s}}\right) = 2 \Rightarrow \theta = \tan^{-1} 2 \approx 63^\circ$$



11. (d): Electric fields due to the charges at the opposite corners will cancel each other.

12. (a): Here, $v_{\text{car}} = \frac{36 \text{ km}}{\text{h}} = 10 \text{ m/s}$

Let the car travel from

C_1 to C_2 in 1 sec.

so $C_1 C_2 = (10 \text{ m/s})(1 \text{ s}) = 10 \text{ m}$

Hence $C_1 M = (10/2) \text{ m} = 5 \text{ m}$

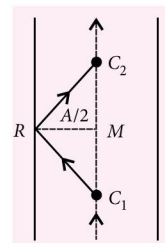
Sound travels from C_1 to R and

R to C_2 in 1s, then $C_1 R$

= $(330 \text{ m/s})(0.5 \text{ s}) = 165 \text{ m}$

Using Pythagoras theorem,

$$\left(\frac{A}{2}\right)^2 = 165^2 - 5^2; d = 2 \cdot \sqrt{165^2 - 5^2} \text{ m}$$



MONTHLY TEST DRIVE CLASS XI ANSWER KEY

- | | | | | |
|------------|------------|------------|------------|------------|
| 1. (c) | 2. (b) | 3. (b) | 4. (a) | 5. (c) |
| 6. (b) | 7. (a) | 8. (a) | 9. (c) | 10. (d) |
| 11. (a) | 12. (a) | 13. (d) | 14. (d) | 15. (b) |
| 16. (b) | 17. (b) | 18. (a) | 19. (a, c) | 20. (b, d) |
| 21. (a, d) | 22. (a, d) | 23. (b, c) | 24. (40) | 25. (2) |
| 26. (3) | 27. (6.30) | 28. (b) | 29. (a) | 30. (d) |

13. (d): We know, $\lambda = \frac{hc}{E}$ i.e., $\lambda \propto \frac{1}{\text{energy difference}}$

$$\text{Now, } \lambda_1 = \frac{hc}{-E - (-2E)} = \frac{hc}{E} \quad \dots(i)$$

$$\lambda_2 = \frac{hc}{-E - \left(-\frac{4}{3}E\right)} = \frac{hc}{\left(\frac{E}{3}\right)} \quad \dots(ii)$$

Dividing eqn. (i) by eq. (ii), we get $\frac{\lambda_1}{\lambda_2} = \frac{1}{3}$

14. (d): For a monoatomic gas, $\gamma = 5/3$

For a rigid diatomic gas, $\gamma = 7/5$

For non-rigid diatomic gas, $\gamma = 9/7$

and for a triatomic rigid molecule, $\gamma = 4/3$

15. (a): D_1 is forward biased and D_2 is reverse biased.
So, no current will flow from D_2 or 3 Ω .

$$\text{The } R_{\text{eff}} = 2 \Omega + 4 \Omega = 6 \Omega ; I_{4\Omega} = \frac{12 \text{ V}}{6 \Omega} = 2 \text{ A.}$$

16. (c)

17. (d): As, $F = \frac{\mu_0 I \cdot I}{2\pi d}$

$$F' = \frac{\mu_0 (I/3)(I/3)}{2\pi(2d)} = \left(\frac{\mu_0 I \cdot I}{2\pi d}\right) \left(\frac{1}{18}\right) = \frac{F}{18}$$

18. (c): Average velocity in 20 s

$$= \frac{\text{Total displacement at } 20^{\text{th}} \text{ s}}{20 \text{ s}} = \frac{20 \text{ m}}{20 \text{ s}} = 1 \text{ m/s.}$$

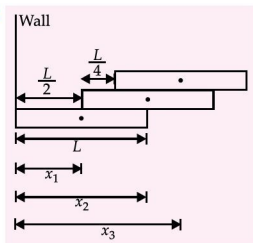
19. (c)

20. (c): Substances expand on heating and contract on cooling.

21. (31): $d = \sqrt{2Rh}$

$$= \sqrt{2 \times (6400 \times 10^3 \text{ m}) \times (75 \text{ m})} = 31 \text{ km}$$

22. (11):



From figure, $x_1 = \frac{L}{2}$, $x_2 = \frac{L}{2} + \frac{L}{2} = L$

$$\text{and } x_3 = \frac{L}{2} + \frac{L}{4} + \frac{L}{2} = \frac{5}{4}L$$

$$\therefore X_{CM} = \frac{m_1 x_1 + m_2 x_2 + m_3 x_3}{m_1 + m_2 + m_3}$$

$$= \frac{M \times \frac{L}{2} + M \times L + M \times \frac{5L}{4}}{M + M + M} = \frac{\frac{11}{4}ML}{3M} = \frac{11}{12}L$$

23. (458): For tangent galvanometer, $I = \frac{2rH}{\mu_0 N} \tan \theta$

$$\Rightarrow N = \frac{2rH \tan \theta}{\mu_0 \cdot I} = \frac{2 \times (16 \times 10^{-2})(0.36 \times 10^{-4})(\tan 45^\circ)}{(4\pi \times 10^{-7})(20 \times 10^{-3})}$$

$N = 458$ turns.

24. (915): Pressure at the interface level due to the left arm and right arm can be equated.

$$(P_{\text{int}})_{\text{left}} = (P_{\text{int}})_{\text{right}} ; P_0 + \rho_x \cdot g \cdot (l + d) = P_0 + \rho_w \cdot l \cdot g$$

$$\Rightarrow \rho_x = \frac{\rho_w \cdot l}{(l + d)} = (998 \text{ kg/m}^3) \cdot \frac{135 \text{ mm}}{(135 + 12.3) \text{ mm}} = 915 \text{ kg/m}^3.$$

25. (3): Given: $P = 100 \text{ W}$, $r = 3 \text{ m}$

We know that, intensity, $I = \frac{1}{2} c \epsilon_0 E^2$ or $E^2 \propto I$

$$\text{Intensity, } I = \frac{P}{4\pi r^2} \quad \text{So, } E^2 \propto \frac{P}{4\pi r^2}$$

$$\text{In first case, } E^2 \propto \frac{100}{4\pi r^2} \quad \dots(i)$$

$$\text{In second case, } \left(\sqrt{\frac{x}{5}} E\right)^2 \propto \frac{60}{4\pi r^2} \quad \dots(ii)$$

Dividing equation (ii) by (i), we get

$$\left(\sqrt{\frac{x}{5}}\right)^2 = \frac{60}{100} = \frac{6}{10} \quad \text{or } \frac{x}{5} = \frac{6}{10} \quad \text{or } x = 3$$

26. (34): The mean temperature of coffee as it cools from 50°C to 45°C is $\left(\frac{50 + 45}{2}\right)^\circ\text{C} = 47.5^\circ\text{C}$.

The rate of decrease of temperature is

$$\frac{50^\circ\text{C} - 45^\circ\text{C}}{5 \text{ min}} = \frac{1^\circ\text{C}}{\text{min}}$$

Newton's law of cooling is $\frac{d\theta}{dt} = -K(\theta - \theta_0)$

$$\Rightarrow \frac{-1^\circ\text{C}}{\text{min}} = K[47.5 - \theta_0] \quad \dots(i)$$

Since, the time taken for the temperature to become 40°C is 8 minutes,

$$\text{During this period, } \frac{d\theta}{dt} = \left[\frac{45^\circ\text{C} - 40^\circ\text{C}}{8 \text{ min}}\right] = \frac{5^\circ\text{C}}{8 \text{ min}}$$

The mean temperature is $\left(\frac{45 + 40}{2}\right)^\circ\text{C} = 42.5^\circ\text{C}$

Now, $\frac{-d\theta}{dt} = K(\theta - \theta_0) \Rightarrow \frac{-5^\circ\text{C}}{8 \text{ min}} \text{ or } K[42.5 - \theta_0]$... (ii)

From eqn. (i) and (ii), we get

$$\frac{8}{5} = \frac{47.5 - \theta_0}{42.5 - \theta_0} \Rightarrow \theta_0 = 34^\circ\text{C}.$$

or $\theta_0 = 34.1^\circ\text{C} \Rightarrow \theta_0 = 34^\circ\text{C}.$

27. (9) : $\lambda_A = 25\lambda, \lambda_B = 16\lambda, N = N_0 e^{-\lambda t}$

$$\frac{N_A}{N_B} = \frac{e^{-\lambda_A t}}{e^{-\lambda_B t}} = e^{(\lambda_B - \lambda_A)t}$$

According to question $e = e^{(\lambda_A - \lambda_B)t}$

$$\lambda_A - \lambda_B = \frac{1}{t}, t = \frac{1}{\lambda_A - \lambda_B} = \frac{1}{25\lambda - 16\lambda} = \frac{1}{9\lambda}$$

28. (3) : Let distance $AC = x$

When the block moves from point B to C,

$$V_C^2 - V_B^2 = 2 \times (g \sin \theta) (2x)$$

or $V_C^2 = 0 + 2(g \sin \theta) 2x$... (i)

When the block moves from point C to A,

$$V_A^2 - V_C^2 = 2(g \sin \theta - \mu g \cos \theta) \times x$$
 ... (ii)

$$V_C^2 = -2g(\sin \theta - \mu \cos \theta) \times x \text{ ... (iii) } [\because V_A = 0]$$

From equation (i) and (iii),

$$2g \sin \theta \times 2x = 2g(\mu \cos \theta - \sin \theta) \times x$$

or $3 \tan \theta = \mu \Rightarrow \text{so, } k = 3$

29. (8) : Using Gauss's theorem, total flux is $E \times A = \frac{q_{\text{net}}}{\epsilon_0}$

$$E \times 4\pi a^2 = \frac{\int_0^a kr4\pi r^2 dr}{\epsilon_0} \quad \left\{ \because q_{\text{net}} = \int \rho(r) \times dV \right\}$$

$$\Rightarrow E = \frac{k4\pi a^2}{4 \times 4\pi \epsilon_0} = \frac{ka^2}{4\epsilon_0}$$
 ... (i)

$$\text{Also, } 2Q = \int_0^R \rho(r)4\pi r^2 dr = \int_0^R kr4\pi r^2 dr = \left[\frac{4\pi kr^4}{4} \right]_0^R$$

$$\Rightarrow k = \frac{2Q}{\pi R^4}$$
 ... (ii)

$$\text{Net force, } F = Q \times E = \frac{1}{4\pi \epsilon_0} \frac{Q^2}{(2a)^2}$$
 ... (iii)

Using (i), (ii) and (iii), $R = a8^{1/4} \Rightarrow a = R8^{-1/4}$

30. (1.67) : Here, critical angle, $C = \sin^{-1}(0.6)$ and $\sin C = 1/\mu$ where μ is the refractive index of the medium.

$$\therefore \mu = \frac{1}{\sin C} = \frac{1}{\sin[\sin^{-1}(0.6)]} = \frac{1}{0.6}$$

According to Brewster's law, $\mu = \tan i_p$ where i_p is the polarizing angle.

$$\therefore i_p = \tan^{-1}(\mu) = \tan^{-1}\left(\frac{1}{0.6}\right) = \tan^{-1}(1.67)$$



PUBLIC NOTICE

JEE Main Session 2

Inviting Online Applications for Joint Entrance Examination (Main) – 2023 Session 2 - Reg.

In continuation of the Public Notice dated: 15 December 2022, the National Testing Agency is now inviting online Application Forms for Joint Entrance Examination (Main) – 2023 Session 2. The schedule for the same is given below :

Examination / Session	Dates of Examination	Submission of Application Forms Online	Last Date for Payment of Application Fee Online
JEE (Main) – 2023 Session 2	06, 08, 10, 11, and 12 April 2023 (Reserve dates – 13, 15 April 2023)	14 February to 12 March 2023 (up to 09:00 P.M.)	12 March 2023 (up to 11:50 P.M.)

The dates of Advance Intimation of Examination City, downloading of Admit Cards, and declaration of Result will be displayed on JEE (Main) portal in due course.

The candidates who have applied and successfully paid the Examination Fee for JEE (Main) – 2023 Session 1 and wish to appear for JEE (Main) – 2023 Session 2, are required to log in with their previous Application Number and Password as provided in Session 1. They may only choose the **Paper, Medium of the Examination, State code of Eligibility and cities for Session 2 and pay the Examination Fees.**

The candidates are not allowed to fill more than one Application Form. Any candidate with more than one Application Number will be treated as UFM (Unfair Means), even if found at a later stage, and strict action will be taken against that Candidate.

The candidates who have already registered for Session 1 are not required to register again.

Those candidates who have not applied earlier, need to apply afresh as per the schedule given. For details, candidates may refer to the table below.

1. Existing candidates i.e. candidates registered for Session 1 and Paid Fee be considered for Session 2	Already registered candidates in Session 1 i.e. existing candidates for Session 2 : Candidates are allowed to opt for the following: i. Course (Paper) ii. Medium of Question Paper iii. State code of Eligibility iv. Examination Cities v. Fee Payment
2. For new candidates, the process for registration and application form filling in Session 2 will remain the same as followed in Session 1.	For new candidates in Session 2 i.e. not registered including Fee not paid for Session 1 : Process for registration and Application will remain the same as followed for Session 1.

The Candidates are advised to keep visiting the official websites of NTA (www.nta.ac.in) and (<https://jeemain.nta.nic.in/>) for the latest updates. For further clarification related to JEE (Main) – 2023, the candidates can also contact 011- 40759000/011-69227700 or email at jeemain@nta.ac.in.

PRACTICE PAPER

NEET 2023



SECTION - A

1. A string of mass 3 kg is under tension of 400 N. The length of the stretched string is 25 cm. If the transverse jerk is stuck at one end of the string how long does the disturbance take to reach the other end?

(a) 0.043 s (b) 0.055 s
(c) 0.034 s (d) 0.065 s

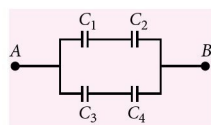
2. Equal charges q each are placed at the vertices A and B of an equilateral triangle ABC of side a . The magnitude of electric field intensity at the point C is

(a) $\frac{q}{4\pi\epsilon_0 a^2}$ (b) $\frac{\sqrt{2}q}{4\pi\epsilon_0 a^2}$
(c) $\frac{\sqrt{3}q}{4\pi\epsilon_0 a^2}$ (d) $\frac{2q}{4\pi\epsilon_0 a^2}$

3. If the velocity of a particle is $v = At + Bt^2$, where A and B are constants, then the distance travelled by it between 1 s and 2 s is

(a) $\frac{3}{2}A + \frac{7}{3}B$ (b) $\frac{A}{2} + \frac{B}{3}$
(c) $\frac{3}{2}A + 4B$ (d) $3A + 7B$

4. Find out the effective capacitance between points A and B as shown in the figure. Here $C_1 = C_2 = 20 \mu\text{F}$ and $C_3 = C_4 = 10 \mu\text{F}$



(a) $10 \mu\text{F}$ (b) $15 \mu\text{F}$ (c) $20 \mu\text{F}$ (d) $25 \mu\text{F}$

5. If $\vec{A} = \vec{B} + \vec{C}$ and $\vec{A}, \vec{B}, \vec{C}$ have scalar magnitudes of 5, 4, 3 units respectively then the angle between $\vec{A}$ and $\vec{C}$ is

(a) $\cos^{-1}\left(\frac{3}{5}\right)$ (b) $\cos^{-1}\left(\frac{4}{5}\right)$
(c) $\frac{\pi}{2}$ (d) $\sin^{-1}\left(\frac{3}{4}\right)$

6. A 1 m long wire of diameter 0.31 mm has a resistance of 4.2 ohms. If it is replaced by another wire of same material of length 1.5 m and diameter 0.155 mm, the resistance of wire is
(a) 25.2 ohms (b) 0.6 ohms
(c) 26.7 ohms (d) 0.8 ohms

7. A gun applies a force F on a bullet which is given by $F = (100 - 0.5 \times 10^5 t)$ N. The bullet emerges out with speed 400 m s^{-1} . Then find out the impulse exerted till force on bullet becomes zero

(a) 0.2 N s (b) 0.3 N s
(c) 0.1 N s (d) 0.4 N s

8. An electron and a proton, both having the same kinetic energy, enter a region of uniform magnetic field, in a plane perpendicular to the field. If their masses are denoted by m_e and m_p respectively, then the ratio of the radii (electron to proton) of their circular orbits is

(a) $\sqrt{\frac{m_p}{m_e}}$ (b) $\sqrt{\frac{m_e}{m_p}}$ (c) $\frac{m_e}{m_p}$ (d) 1

9. If the linear momentum is increased by 50%, then kinetic energy will increase by
(a) 50% (b) 100% (c) 125% (d) 25%

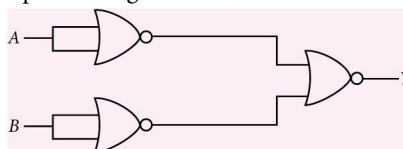
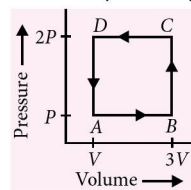
10. At certain place, the horizontal component of earth's magnetic field is 3.0 G and the angle dip at that place is 30° . The magnetic field of earth at that location

(a) 4.5 G (b) 5.1 G (c) 3.5 G (d) 6.0 G

11. The moment of inertia of a disc of mass M and radius R about an axis, which is tangential to the circumference of the disc and parallel to its diameter is

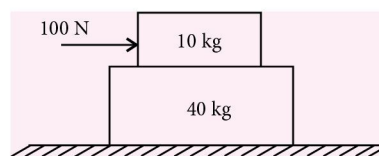
(a) $\frac{3}{2}MR^2$ (b) $\frac{2}{3}MR^2$
(c) $\frac{5}{4}MR^2$ (d) $\frac{4}{5}MR^2$

12. An electric dipole is placed at an angle of 30° with an electric field intensity $2 \times 10^5 \text{ N C}^{-1}$. It experiences a torque equal to 4 N m . The charge on the dipole, if the dipole length is 2 cm , is
(a) 8 mC (b) 2 mC (c) 5 mC (d) $7 \mu\text{C}$
13. The escape velocity from the surface of earth is 11.2 km s^{-1} . What is the escape velocity in a planet whose radius is three times that of earth and on which the acceleration due to gravity is three times of that on earth?
(a) 11.2 km s^{-1} (b) 22.4 km s^{-1}
(c) 33.6 km s^{-1} (d) 5.6 km s^{-1}
14. When an AC source of e.m.f. $E = E_0 \sin(100t)$ is connected across a circuit, the phase difference between the e.m.f. E and the current I is observed to be $\pi/4$, as shown in the figure. If the circuit consists possible only of R - C or R - L in series, which of the following combinations is possible?
(a) $R = 1 \text{ k}\Omega$, $C = 10 \mu\text{F}$
(b) $R = 1 \text{ k}\Omega$, $C = 1 \mu\text{F}$
(c) $R = 1 \text{ k}\Omega$, $L = 10 \text{ H}$
(d) $R = 1 \text{ k}\Omega$, $L = 1 \text{ H}$
15. Two wires of same length and same material but of radii r and $2r$ are stretched by forces F and f respectively to produce equal elongation. The ratio F to f is
(a) $1:1$ (b) $1:2$ (c) $2:1$ (d) $1:4$
16. An em wave is propagating in a medium with a velocity $\vec{v} = v\hat{i}$. The instantaneous oscillating electric field of this em wave is along $+y$ axis. Then the direction of oscillating magnetic field of the em wave will be along
(a) $-z$ direction (b) $+z$ direction
(c) $-y$ direction (d) $-x$ direction
17. Two identical glass ($\mu_g = 3/2$) equiconvex lenses of focal length f each are kept in contact. The space between the two lenses is filled with water ($\mu_w = 4/3$). The focal length of the combination is
(a) $f/3$ (b) f (c) $4f/3$ (d) $3f/4$
18. An object floats in water with 10% of its volume outside and in oil 30% of its volume outside. The specific gravity of the oil is
(a) 1.3 (b) 0.33 (c) 2 (d) 7
19. To observe diffraction, the size of the obstacle
(a) should be $\lambda/2$, where λ is the wavelength.
(b) should be of the order of wavelength.
(c) has no relation to wavelength.
(d) should be much larger than the wavelength.
20. The temperature of an object is 60°C . Its value in Fahrenheit scale is
(a) 120°F (b) 130°F (c) 140°F (d) 110°F
21. When the energy of the incident radiation is increased by 20%, the kinetic energy of the photoelectrons emitted from a metal surface increased from 0.5 eV to 0.8 eV . The work function of the metal is
(a) 0.65 eV (b) 1.0 eV
(c) 1.3 eV (d) 1.5 eV
22. A thermodynamic system is taken through the cycle $ABCD$ as shown in figure. Heat rejected by the gas during the cycle is
(a) $2PV$
(b) $4PV$
(c) $\frac{1}{2}PV$
(d) PV
23. In a hydrogen like atom electron makes transition from an energy level with quantum number n to another with quantum number $(n-1)$. If $n \gg 1$, the frequency of radiation emitted is proportional to
(a) $\frac{1}{n^3}$ (b) $\frac{1}{n}$ (c) $\frac{1}{n^2}$ (d) $\frac{1}{n^{3/2}}$
24. The molecules of a given mass of a gas have r.m.s. velocity of 200 m s^{-1} at 27°C and $1.0 \times 10^5 \text{ N m}^{-2}$ pressure. When the temperature and pressure of the gas are respectively, 127°C and $0.05 \times 10^5 \text{ N m}^{-2}$, the r.m.s. velocity of its molecules in m s^{-1} is
(a) $\frac{100\sqrt{2}}{3}$ (b) $\frac{100}{3}$
(c) $100\sqrt{2}$ (d) $\frac{400}{\sqrt{3}}$
25. An atom of mass number 15 and atomic number 7 captures an α -particle and then emits a proton. The mass number and atomic number of the resulting atom will be respectively
(a) 14 and 2 (b) 15 and 3
(c) 16 and 4 (d) 18 and 8
26. The amplitude of the SHM is
 $x = 5[\sin 3\pi t + \sqrt{3} \cos 3\pi t]$
(a) 10 (b) 20 (c) 1 (d) 5
27. Output of the given circuit is



- (a) $\overline{A \cdot B}$ (b) $A \cdot B$ (c) $\overline{A + B}$ (d) $\overline{A + B}$

28. The phase difference between two vibrating particles separated by a distance of 11 m into medium through which a progressive wave is travelling is 1320° . If the frequency of the disturbance is 105 Hz, the phase velocity of the progressive wave is
 (a) 315 m s^{-1} (b) 330 m s^{-1}
 (c) 350 m s^{-1} (d) 300 m s^{-1}
29. 1000 kHz carrier wave is amplitude modulated by the signal frequency 200 - 4000 Hz. The channel width of this case is
 (a) 8 kHz (b) 4 kHz
 (c) 7.6 kHz (d) 3.8 kHz
30. Which of the following ratios has the dimension of mass?
 (a) Volume/Density
 (b) Surface tension/(Angular velocity)²
 (c) Linear momentum/Force
 (d) Pressure/Power
31. A particle A has charge $+q$ and particle B has charge $+4q$, each of them having the same mass m . When allowed to fall from rest through the same electrical potential difference, the ratio of their speeds will become
 (a) 2 : 1 (b) 1 : 2 (c) 1 : 4 (d) 4 : 1
32. A projectile is given an initial velocity of $\hat{i} + 2\hat{j}$. The cartesian equation of its path is (Take $g = 10 \text{ m s}^{-2}$)
 (a) $y = x - 5x^2$ (b) $y = 2x - 5x^2$
 (c) $y = 2x - 15x^2$ (d) $y = 2x - 25x^2$
33. Six resistances each of value $r = 6 \Omega$ are connected between points A, B and C as shown in the figure. If R_1 , R_2 and R_3 are the net resistances between A and B, between B and C and between A and C respectively, then $R_1 : R_2 : R_3$ will be equal to
 (a) 6 : 3 : 2 (b) 1 : 2 : 3
 (c) 5 : 4 : 3 (d) 4 : 3 : 2
34. A 40 kg slab rests on a frictionless floor. A 10 kg block rests on top of the slab as shown in the figure. The coefficient of static friction between the block and the slab is 0.60 while the coefficient of kinetic friction between the block and slab is 0.40. The 10 kg block is acted upon by a horizontal force of 100 N. If $g = 9.8 \text{ m/s}^2$, the resulting acceleration of the slab will be



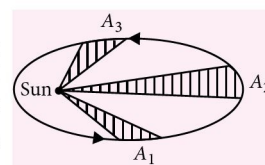
- (a) 0.98 m/s^2 (b) 1.47 m/s^2
 (c) 1.52 m/s^2 (d) 6.1 m/s^2

35. A certain length of insulated wire can be bent to form either a single circular loop (case I) or a double loop of smaller radius (case II). When the same steady current is passed through the wire, the ratio of the magnetic field at the centre in case I to that in case II is
 (a) 1 (b) 2 (c) 1/2 (d) 1/4

SECTION - B

Attempt any 10 questions out of 15.

36. A ball impinges directly on a similar ball at rest. The first ball is brought to rest by the impact. If half of the kinetic energy is lost by impact, the value of coefficient of restitution is
 (a) $\frac{1}{2\sqrt{2}}$ (b) $\frac{1}{\sqrt{3}}$ (c) $\frac{1}{\sqrt{2}}$ (d) $\frac{\sqrt{3}}{2}$
37. A coil has 1000 turns and 500 cm^2 as its area. The plane of the coil is placed perpendicular to a uniform magnetic field of $2 \times 10^{-5} \text{ T}$. The coil is rotated through 180° in 0.2 seconds. The average emf induced in the coil, in mV is
 (a) 5 (b) 10 (c) 15 (d) 20
38. An isolated particle of mass m is moving in a horizontal plane (x - y) along the x -axis, at a certain height above the ground. It suddenly explodes into two fragments of masses $m/4$ and $3m/4$. An instant later, the smaller fragment is at $y = +15 \text{ cm}$. The larger fragment at this instant is at
 (a) $y = -5 \text{ cm}$ (b) $y = +20 \text{ cm}$
 (c) $y = +5 \text{ cm}$ (d) $y = -20 \text{ cm}$
39. A transformer with efficiency 80% works at 4 kW and 100 V. If the secondary voltage is 200V, then the primary and secondary currents are respectively
 (a) 40 A and 16 A (b) 16 A and 40 A
 (c) 20 A and 40 A (d) 40 A and 20 A
40. A planet moving around sun sweeps area A_1 in 2 days, A_2 in 3 days and A_3 in 6 days. Then the relation between A_1 , A_2 and A_3 is



- (a) $3A_1 = 2A_2 = A_3$ (b) $2A_1 = 3A_2 = 6A_3$
 (c) $3A_1 = 2A_2 = 6A_3$ (d) $6A_1 = 3A_2 = 2A_3$

41. The correct order of arrangement of electromagnetic waves according to their wavelength is

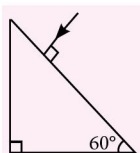
- (a) Gamma rays < Micro waves < AM radio waves < FM radio waves
 (b) Micro waves < AM radio waves < FM radio wave < Gamma rays
 (c) Gamma rays < AM radio waves < FM radio wave < Micro waves
 (d) Gamma rays < Micro waves < FM radio waves < AM radio waves

42. Three liquids of densities ρ_1 , ρ_2 and ρ_3 (with $\rho_1 > \rho_2 > \rho_3$), having the same value of surface tension T , rise to the same height in three identical capillaries. The angles of contact θ_1 , θ_2 and θ_3 obey

- (a) $\frac{\pi}{2} > \theta_1 > \theta_2 > \theta_3 \geq 0$
 (b) $0 \leq \theta_1 < \theta_2 < \theta_3 < \frac{\pi}{2}$
 (c) $\frac{\pi}{2} < \theta_1 < \theta_2 < \theta_3 < \pi$
 (d) $\pi > \theta_1 > \theta_2 > \theta_3 > \frac{\pi}{2}$

43. Find the value of the angle of emergence from the prism. Refractive index of the glass is $\sqrt{3}$.

- (a) 90° (b) 60°
 (c) 30° (d) 45°



44. A gas bubble of 2 cm diameter rises through a liquid of density 1.75 gm cm^{-3} with a fixed speed of 0.35 cm s^{-1} . Neglect the density of the gas. The co-efficient of viscosity of the liquid is

- (a) 870 poise (b) 1120 poise
 (c) 982 poise (d) 1089 poise

45. The interference pattern is obtained with two coherent light sources of intensity ratio n . In the interference pattern, the ratio $\frac{I_{\max} - I_{\min}}{I_{\max} + I_{\min}}$ will be

- (a) $\frac{\sqrt{n}}{n+1}$ (b) $\frac{2\sqrt{n}}{n+1}$
 (c) $\frac{\sqrt{n}}{(n+1)^2}$ (d) $\frac{2\sqrt{n}}{(n+1)^2}$

46. A bullet fired from a rifle loses 20% of its speed while passing through a wooden plank. Then minimum number of wooden planks required to completely stop the bullet is

- (a) 3 (b) 5 (c) 15 (d) 25

47. _____ $3E$
 _____ $5E/3$
 _____ E

The figure shows the energy levels of certain atom. When the electron de-excites from $3E$ to E , an electromagnetic wave of wavelength λ is emitted. What is the wavelength of the electromagnetic wave

emitted, when the electron de-excites from $\frac{5E}{3}$ to E ?

- (a) 3λ (b) 2λ (c) 5λ (d) $3\lambda/5$

48. 1 g of ice and 1 g of steam are mixed together. The amount of water in the mixture is

- (a) $\frac{4}{3} \text{ g}$ (b) $\frac{1}{3} \text{ g}$ (c) 2 g (d) zero

49. The ratio of the respective de Broglie wavelengths associated with electrons accelerated from rest with the voltages 100 V, 200 V and 300 V is

- (a) 1 : 2 : 3 (b) 1 : 4 : 9
 (c) $1 : \frac{1}{\sqrt{2}} : \frac{1}{\sqrt{3}}$ (d) $1 : \frac{1}{2} : \frac{1}{3}$

50. In an experiment, the percentage of error occurred in the measurement of physical quantities A , B , C and D are 1%, 2%, 3% and 4% respectively. Then the maximum percentage of error in the measurement

X , where $X = \frac{A^2 B^{1/2}}{C^{1/3} D^3}$, will be

- (a) 10% (b) $(3/13)\%$
 (c) 16% (d) -10%



NEET

ONLINE TEST SERIES

Practice Part Syllabus/ Full syllabus
24 Mock Tests

**Now on your android smart phones
with the same login of web portal.**

Log on to test.pcmbtoday.com

SOLUTIONS

1. (a) : Here,

Mass of the string, $m = 3 \text{ kg}$

Length of the string, $L = 25 \text{ cm} = 25 \times 10^{-2} \text{ m}$

Tension in the string, $T = 400 \text{ N}$

Mass per unit length of the string,

$$\mu = \frac{m}{L} = \frac{3 \text{ kg}}{25 \times 10^{-2} \text{ m}} = 12 \text{ kg m}^{-1}$$

Speed of the wave on the string is

$$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{400 \text{ N}}{12 \text{ kg m}^{-1}}} = 5.77 \text{ m s}^{-1}$$

Time taken by disturbance to reach the other end

$$t = \frac{L}{v} = \frac{25 \times 10^{-2} \text{ m}}{5.77 \text{ m s}^{-1}} = 0.043 \text{ s}$$

2. (c) : The situation is as shown in the figure.

Electric field intensity at C due to charge q at A is

$$E_1 = \frac{1}{4\pi\epsilon_0} \frac{q}{a^2} \text{ along AC}$$

Electric field intensity at C due to charge q at B is

$$E_2 = \frac{1}{4\pi\epsilon_0} \frac{q}{a^2} \text{ along BC}$$

$$\text{As } E_1 = E_2 = \frac{1}{4\pi\epsilon_0} \frac{q}{a^2}$$

E_1 and E_2 are inclined at angle 60° , therefore the resultant electric field intensity at C is

$$E = \sqrt{E_1^2 + E_2^2 + 2E_1E_2 \cos 60^\circ}$$

$$= \sqrt{E_1^2 + E_1^2 + 2E_1^2 \cos 60^\circ} = E_1 \sqrt{3} = \frac{1}{4\pi\epsilon_0} \frac{q\sqrt{3}}{a^2}$$

3. (a) : Velocity of the particle is $v = At + Bt^2$

$$\frac{ds}{dt} = At + Bt^2, \int ds = \int (At + Bt^2) dt,$$

$$\therefore s = \frac{At^2}{2} + B \frac{t^3}{3} + C$$

$$s(t=1\text{ s}) = \frac{A}{2} + \frac{B}{3} + C, s(t=2\text{ s}) = 2A + \frac{8}{3}B + C,$$

Required distance $= s(t=2\text{ s}) - s(t=1\text{ s})$

$$= \left(2A + \frac{8}{3}B + C\right) - \left(\frac{A}{2} + \frac{B}{3} + C\right) = \frac{3}{2}A + \frac{7}{3}B$$

4. (b) : Here, C_1 and C_2 are in series. Hence, their effective capacitance C' is given by

$$\frac{1}{C'} = \frac{1}{C_1} + \frac{1}{C_2}, \frac{1}{C'} = \frac{1}{20} + \frac{1}{20}$$

$$\Rightarrow C' = 10 \mu\text{F}$$

$$\text{Similarly, } \frac{1}{C''} = \frac{1}{C_3} + \frac{1}{C_4}$$

$$\frac{1}{C''} = \frac{1}{10} + \frac{1}{10} \Rightarrow C'' = 5 \mu\text{F}$$

Here C' and C'' are in parallel. Hence, the equivalent capacitance between points A and B is

$$C_{AB} = C' + C'' = 10 + 5 = 15 \mu\text{F}$$

5. (a) : Given : $A = |\vec{A}| = 5$

$$B = |\vec{B}| = 4, C = |\vec{C}| = 3$$

$$\text{As } 5^2 = 4^2 + 3^2$$

$$A^2 = B^2 + C^2$$

$\therefore$ Angle between $\vec{B}$ and $\vec{C}$ is 90° .

If θ is the angle between $\vec{A}$ and $\vec{C}$, then

$$\cos \theta = \frac{C}{A} = \frac{3}{5} \text{ or } \theta = \cos^{-1}\left(\frac{3}{5}\right)$$

6. (a) : Here, $R_1 = 4.2 \Omega$; $r_1 = \frac{0.31}{2} \text{ mm}$, $l_1 = 1 \text{ m}$

$$\text{and } r_2 = \frac{0.155}{2} \text{ mm}, l_2 = 1.5 \text{ m}$$

$$R = \rho \frac{l}{A} \quad (\rho \text{ is constant for same material})$$

$$\therefore \frac{R_1}{R_2} = \frac{l_1/A_1}{l_2/A_2} = \frac{A_2}{A_1} \times \frac{l_1}{l_2}$$

$$R_2 = R_1 \times \frac{A_1}{A_2} \times \frac{l_2}{l_1} = 4.2 \times \frac{\pi r_1^2}{\pi r_2^2} \times \frac{l_2}{l_1} = 4.2 \left(\frac{r_1}{r_2}\right)^2 \frac{l_2}{l_1}$$

$$= 4.2 \times \left(\frac{\frac{0.31}{2} \times 10^{-3}}{\frac{0.155}{2} \times 10^{-3}}\right)^2 \times \frac{1.5}{1} = 4.2 \times (2)^2 \times 1.5$$

$$= 25.2 \text{ ohms}$$

7. (c) : Given, force $F = (100 - 0.5 \times 10^5 t) \text{ N}$

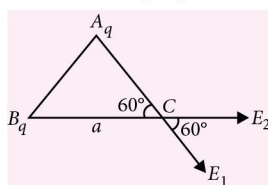
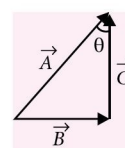
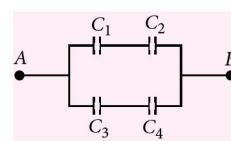
$$100 - 0.5 \times 10^5 t = 0, 100 = 0.5 \times 10^5 t \quad (\because F = 0)$$

$$t = 2 \times 10^{-3} \text{ sec}$$

$$\text{Impulse, } I = \int F dt = \int_0^{2 \times 10^{-3}} (100 - 0.5 \times 10^5 t) dt$$

$$I = \left[100t - \frac{10^5 t^2}{2} \right]_0^{2 \times 10^{-3}}$$

$$I = \left[100 \times 2 \times 10^{-3} - \frac{10^5}{4} \times 4 \times 10^{-6} \right] = 10^{-1} = 0.1 \text{ N s}$$



Last-minute check on your NEET readiness



₹ 800/-



MTG's NEET Explorer helps students self-assess their readiness for success in NEET. Attempting the tests put together by MTG's experienced team of editors and experts strictly on the NEET pattern and matching difficulty levels, students can easily measure their preparedness for success.

Order now!



Scan to buy on mtg.in

HIGHLIGHTS:

- 10 Model Test Papers based on latest NEET syllabus
- Last 10 years' solved test papers of AIPMT/NEET
- Includes NEET 2022 solved paper
- OMR Sheet provided after each Model Test Paper
- Detailed solutions for self-assessment and to practice time management

8. (b) : Radius of circular path of charged particle of charge q and mass m in a uniform magnetic field B is given by, $r = \frac{mv}{qB}$

Kinetic energy of the charged particle,

$$K = \frac{1}{2}mv^2 \text{ or } v^2 = \frac{2K}{m} \therefore r = \frac{m}{qB} \sqrt{\frac{2K}{m}} = \frac{\sqrt{2Km}}{qB}$$

For the same value of K and B , $r \propto \frac{\sqrt{m}}{q}$

$$\therefore \frac{r_e}{r_p} = \frac{\sqrt{m_e}}{\sqrt{m_p}} \times \frac{q_p}{q_e} = \sqrt{\frac{m_e}{m_p}} \times \frac{e}{e} = \sqrt{\frac{m_e}{m_p}}$$

9. (c) : Kinetic energy of a body, $K = \frac{p^2}{2m}$

where p is the momentum of the body and m is the mass of the body $p' = p + \frac{50}{100}p = \frac{3}{2}p$

Assuming m remains constant

$$\therefore \frac{K'}{K} = \left(\frac{p'}{p}\right)^2 = \frac{9}{4}$$

$$\% \text{ increase in kinetic energy} = \frac{K' - K}{K} \times 100\%$$

$$= \left(\frac{K'}{K} - 1\right) \times 100\% = \left(\frac{9}{4} - 1\right) \times 100\% = 125\%$$

10. (c) : Given $B_H = B \cos \theta = 3 \text{ G}$, $\theta = 30^\circ$

$$B = \frac{B_H}{\cos 30^\circ} = \frac{3}{\sqrt{3}/2} = 2\sqrt{3} = 3.5 \text{ G}$$

11. (c) : The moment of inertia of a disc about

its diameter (i.e. z axis) is $I_0 = \frac{MR^2}{4}$

$\therefore$ According to parallel axes theorem, moment of inertia about the required axis (i.e. z' axis) is

$$I = I_0 + MR^2 = \frac{MR^2}{4} + MR^2 = \frac{5MR^2}{4}$$

12. (b) : Here, $\theta = 30^\circ$, $E = 2 \times 10^5 \text{ N C}^{-1}$

$$\tau = 4 \text{ N m}, l = 2 \text{ cm} = 0.02 \text{ m}$$

$$\tau = pE \sin \theta = (ql)E \sin \theta$$

$$\therefore q = \frac{\tau}{El \sin \theta} = \frac{4}{2 \times 10^5 \times 0.02 \times \frac{1}{2}} = 2 \text{ mC}$$

13. (c) : Here, Radius of the earth $= R_e$
Radius of the planet, $R_p = 3R_e$

Acceleration due to gravity on the surface of earth $= g_e$

Acceleration due to gravity on the surface of planet,

$$g_p = 3g_e$$

Escape velocity from the surface of the earth is

$$v_e = \sqrt{2g_e R_e} = 11.2 \text{ km s}^{-1}$$

Escape velocity from the surface of the planet is

$$v_p = \sqrt{2g_p R_p} = \sqrt{2(3g_e)(3R_e)}$$

$$= 3\sqrt{2g_e R_e} = 3 \times 11.2 \text{ km s}^{-1} = 33.6 \text{ km s}^{-1}$$

14. (a) : Figure given in the question shows that current

I leads the emf E by a phase angle $\frac{\pi}{4}$.

Therefore, the circuit can be R - C circuit alone.

$$\tan \phi = \frac{X_C}{R} = \frac{1}{\omega CR} \left(\because X_C = \frac{1}{\omega C} \right)$$

$$\tan \frac{\pi}{4} = \frac{1}{\omega CR} \Rightarrow 1 = \frac{1}{\omega CR} \quad \dots(i)$$

Compare $E = E_0 \sin(100t)$ with $E = E_0 \sin \omega t$, we get

$$\omega = 100 \text{ rad s}^{-1}$$

$$\therefore CR = \frac{1}{\omega} = \frac{1}{100} \quad (\text{Using (i)})$$

$$\text{When } R = 1 \text{ k}\Omega = 10^3 \Omega, C = \frac{1}{10^5} = 10^{-5} \text{ F} = 10 \mu\text{F}$$

15. (d) : According to definition of Young's modulus

$$Y = \frac{F/A}{\Delta L/L} = \frac{F/\pi r^2}{\Delta L/L}$$

$$\therefore \text{Elongation produced in a wire is, } \Delta L = \frac{FL}{\pi r^2 Y}$$

where L is the length of the wire, r is its radius and F is the stretching force.

As both wires are of same length (L) and same material i.e., Y is same and produce equal elongations

$$\therefore \Delta L_1 = \Delta L_2$$

$$\text{or } \frac{FL}{\pi r^2 Y} = \frac{fL}{\pi (2r)^2 Y} \text{ or } \frac{F}{r^2} = \frac{f}{(2r)^2}$$

$$\text{or } \frac{F}{f} = \frac{r^2}{(2r)^2} = \frac{r^2}{4r^2} = \frac{1}{4}$$

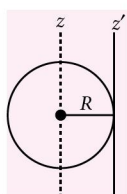
16. (b) : Velocity of em wave in a medium is given by

$$\vec{v} = \vec{E} \times \vec{B}$$

$$\therefore \hat{v} = (\hat{E} \hat{j}) \times (\vec{B}) \quad [\because \vec{E} = E \hat{j} (\text{Given})]$$

$$\text{As } \hat{i} = \hat{j} \times \hat{k} \text{ so } \vec{B} = B \hat{k}$$

Direction of oscillating magnetic field of the em wave will be along $+z$ direction.



17. (d) : Here, $\mu_g = \frac{3}{2}$, $\mu_w = \frac{4}{3}$

Focal length (f) of glass convex lens is given by

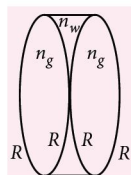
$$\frac{1}{f} = (\mu_g - 1) \left(\frac{2}{R} \right)$$

or $\frac{1}{f} = \left(\frac{3}{2} - 1 \right) \frac{2}{R} = \frac{1}{R}$ or $f = R$... (i)

Focal length (f') of water filled concave lens is given by

$$\frac{1}{f'} = (\mu_w - 1) \left(-\frac{2}{R} \right)$$

or $\frac{1}{f'} = \left(\frac{4}{3} - 1 \right) \left(-\frac{2}{R} \right)$
 $= -\frac{2}{3R} = -\frac{2}{3f}$ [Using eqn. (i)]



Equivalent focal length (f_{eq}) of lens system

$$\frac{1}{f_{eq}} = \frac{1}{f} - \frac{2}{3f} + \frac{1}{f} = \frac{3-2+3}{3f} = \frac{4}{3f}$$

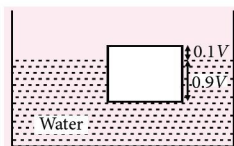
$$\therefore f_{eq} = \frac{3f}{4}$$

18. (a) : Let V be the volume of the object. When the object is floating in the liquid, then

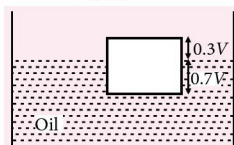
Weight of the object = Weight of the liquid displaced

or $V\rho_{\text{object}}g = V_{\text{inside}}\rho_{\text{liquid}}g$

In water, $V\rho_{\text{object}}g = 0.9V\rho_{\text{water}}g$... (i)



In oil, $V\rho_{\text{object}}g = 0.7V\rho_{\text{oil}}g$... (ii)



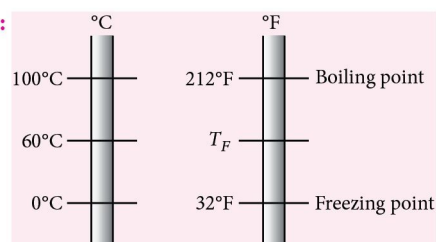
Divide (i) by (ii), we get

$$1 = \frac{0.9\rho_{\text{water}}}{0.7\rho_{\text{oil}}} \text{ or } \frac{\rho_{\text{oil}}}{\rho_{\text{water}}} = \frac{0.9}{0.7} = \frac{9}{7}$$

Specific gravity of the oil = $\frac{\rho_{\text{oil}}}{\rho_{\text{water}}} = \frac{9}{7} = 1.3$

19. (b) : To observe diffraction, the size of the obstacle should be the order of wavelength.

20. (c) :



Let T_F be temperature on Fahrenheit scale corresponding to 60°C on Celsius scale. Then

$$\frac{60-0}{100-0} = \frac{T_F-32}{212-32} \text{ or } \frac{3}{5} = \frac{T_F-32}{180} \text{ or } 5T_F - 160 = 540$$

or $5T_F = 700$ or $T_F = \frac{700}{5} = 140^\circ\text{F}$

21. (b) : According to Einstein's photoelectric equation, The kinetic energy of emitted photoelectrons is

$$K = h\nu - \phi_0$$

where $h\nu$ is the energy of incident radiation and ϕ_0 is work function of the metal.

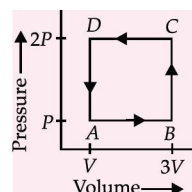
As per question,

$$0.5 \text{ eV} = h\nu - \phi_0 \quad \dots (i)$$

$$0.8 \text{ eV} = 1.2h\nu - \phi_0 \quad \dots (ii)$$

On solving eqns. (i) and (ii), we get $\phi_0 = 1.0 \text{ eV}$

22. (a) : In a cyclic process work done is equal to the area under the cycle and is positive if the cycle is clockwise and negative if it is anticlockwise.



$$\therefore \Delta W = - \text{Area of rectangle}$$

$$ABCD = -P(2V) = -2PV$$

According to first law of thermodynamics

$$\Delta Q = \Delta U + \Delta W$$

But for a cyclic process, $\Delta U = 0$

$$\therefore \Delta Q = \Delta W$$

i.e., heat supplied to the system is equal to the work done. So heat absorbed, $\Delta Q = \Delta W = -2PV$

$$\therefore \text{Heat rejected by the gas} = 2PV$$

23. (a) : In a hydrogen like atom, when an electron makes an transition from an energy level with n to $n-1$, the frequency of emitted radiation is

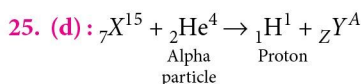
$$\nu = RcZ^2 \left[\frac{1}{(n-1)^2} - \frac{1}{n^2} \right] = \frac{RcZ^2(2n-1)}{n^2(n-1)^2}$$

As $n > 1$

$$\therefore \nu = \frac{RcZ^2 2n}{n^4} = \frac{2RcZ^2}{n^3} \text{ or } \nu \propto \frac{1}{n^3}$$

24. (d) : As, $v_{\text{rms}} = \sqrt{\frac{3k_B T}{m}}$

$$\therefore \frac{v_{27}}{v_{127}} = \sqrt{\frac{27+273}{127+273}} = \frac{\sqrt{3}}{2} \text{ or } v_{127} = \frac{2}{\sqrt{3}} \times v_{27} = \frac{2}{\sqrt{3}} \times 200 \text{ m s}^{-1} = \frac{400}{\sqrt{3}} \text{ m s}^{-1}$$



According to the law of conservation of charge, we get
 $7 + 2 = 1 + Z \Rightarrow Z = 8$

According to the law of conservation of mass, we get

$$15 + 4 = 1 + A \Rightarrow A = 18$$

Hence, the resulting atom has mass number 18 and atomic number 8.

26. (a) : $x = 5[\sin 3\pi t + \sqrt{3} \cos 3\pi t]$

$$x = 10 \left[\frac{1}{2} \sin 3\pi t + \frac{\sqrt{3}}{2} \cos 3\pi t \right]$$

$$= 10 \left(\cos \frac{\pi}{3} \sin 3\pi t + \sin \frac{\pi}{3} \cos 3\pi t \right) = 10 \sin \left(3\pi t + \frac{\pi}{3} \right)$$

$\therefore$ Amplitude of this SHM is $A = 10$

27. (b) : $Y = \overline{A+B} = \overline{A} \cdot \overline{B} = A \cdot B$

28. (a) : Here, Phase difference,

$$\Delta\phi = 1320^\circ = \frac{\pi}{180^\circ} \times 1320^\circ = \frac{22}{3} \pi \text{ rad}$$

Path difference, $\Delta x = 11 \text{ m}$, Frequency, $\nu = 105 \text{ Hz}$

$$\Delta\phi = \frac{2\pi}{\lambda} \times \Delta x \quad \therefore \lambda = \frac{2\pi}{\Delta\phi} \times \Delta x = \frac{2\pi}{\frac{22\pi}{3}} \times 11 \text{ m} = 3 \text{ m}$$

Phase velocity, $v = \nu\lambda = (105 \text{ Hz})(3 \text{ m}) = 315 \text{ m s}^{-1}$

29. (a) : Bandwidth is equal to twice the frequency of modulating signals.

Therefore, bandwidth $= 2 \nu_m$

$$= 2 \times 4000 \text{ Hz} = 8 \times 10^3 \text{ Hz} = 8 \text{ kHz}$$

30. (b) : $\frac{\text{Volume}}{\text{Density}} = \frac{[M^0 L^3 T^0]}{[ML^{-3} T^0]} = [M^{-1} L^6]$

$$\frac{\text{Surface tension}}{(\text{Angular velocity})^2} = \frac{[ML^0 T^{-2}]}{[M^0 L^0 T^{-1}]^2} = [M]$$

$$\frac{\text{Linear momentum}}{\text{Force}} = \frac{[MLT^{-1}]}{[MLT^{-2}]} = [T]$$

$$\frac{\text{Pressure}}{\text{Power}} = \frac{[ML^{-1} T^{-2}]}{[ML^2 T^{-3}]} = [L^{-3} T]$$

31. (b) : Mass of each charged particle $= m$

Let potential difference be V .

The energy of charge $+q$ when passing through potential

difference V , $E = qV = \frac{1}{2} mv^2$

The energy of charge $+4q$ when passing through

potential difference V , $E' = 4qV = \frac{1}{2} mv'^2$

$$\therefore \frac{E}{E'} = \frac{v^2}{v'^2} = \frac{qV}{4qV} = \frac{1}{4} \text{ or } \frac{v}{v'} = \frac{1}{2}$$

32. (b) : Given, $\vec{u} = \hat{i} + 2\hat{j} = u_x \hat{i} + u_y \hat{j}$

Then $u_x = 1 = u \cos \theta$ and $u_y = 2 = u \sin \theta$

$$\therefore \tan \theta = \frac{u \sin \theta}{u \cos \theta} = \frac{2}{1} = 2$$

The equation of trajectory of a projectile motion is

$$y = x \tan \theta - \frac{gx^2}{2u^2 \cos^2 \theta} = x \tan \theta - \frac{gx^2}{2(u \cos \theta)^2}$$

$$\therefore y = x \times 2 - \frac{10 \times x^2}{2(1)^2} = 2x - 5x^2$$

33. (c) : In the branch AC, three resistors each of resistance r are in parallel, so their equivalent resistance is $r/3$. In the branch BC, two resistors each of resistance r are in parallel, so their equivalent resistance is $r/2$.

The equivalent circuit of the given circuit is as shown in adjacent figure.

Net resistance between A and B is

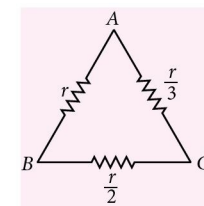
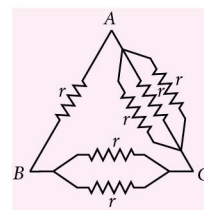
$$R_1 = \frac{\left(\frac{r}{3} + \frac{r}{2} \right) \times r}{\frac{r}{3} + \frac{r}{2} + r} = \frac{5}{11} r$$

Net resistance between B and C is

$$R_2 = \frac{\left(r + \frac{r}{3} \right) \times \frac{r}{2}}{r + \frac{r}{3} + \frac{r}{2}} = \frac{4}{11} r$$

Net resistance between A and C is

$$R_3 = \frac{\left(r + \frac{r}{2} \right) \times \frac{r}{3}}{r + \frac{r}{2} + \frac{r}{3}} = \frac{3}{11} r$$



$$\therefore R_1 : R_2 : R_3 = \frac{5}{11}r : \frac{4}{11}r : \frac{3}{11}r = 5 : 4 : 3$$

34. (a) : Here, mass of the block, $m_1 = 10$ kg

Mass of the slab, $m_2 = 40$ kg

Limiting force of friction of block on slab

$$= \mu_s m_1 g = 0.6 \times 10 \times 9.8 = 58.8 \text{ N}$$

Since the applied force = 100 N on block is greater than force of limiting friction, the block will accelerate on slab. Due to which, the force acting on slab will be that due to kinetic friction ($\mu_k m_1 g$). Hence acceleration of

$$\text{slab } a = \frac{\mu_k m_1 g}{m_2} = \frac{0.4 \times 10 \times 9.8}{40} = 0.98 \text{ m/s}^2$$

35. (d) : Magnetic field at the centre of a current

carrying circular wire, $B = \frac{\mu_0 n I}{2r}$

Let length of the wire be L .

$$\text{Case I : } 2\pi r_1 = L, r_1 = \frac{L}{2\pi}; \therefore B_1 = \frac{\mu_0 I}{2(L/2\pi)}$$

$$\text{Case II : } 2 \times (2\pi r_2) = L; r_2 = \frac{L}{4\pi}; \therefore B_2 = \frac{\mu_0 (2I)}{2(L/4\pi)}$$

$$\text{Hence, } \frac{B_1}{B_2} = \frac{1}{4}$$

36. (c) : Let u_1 and v_1 be the initial and final velocities of ball 1 and u_2 and v_2 be the similar quantities for ball 2. Here, $u_2 = 0$ and $v_1 = 0$.

$$\therefore \text{initial KE, } K_i = \frac{1}{2} m u_1^2 + \frac{1}{2} m u_2^2 = \frac{1}{2} m u_1^2$$

$$\text{and final KE, } K_f = \frac{1}{2} m v_1^2 + \frac{1}{2} m v_2^2 = \frac{1}{2} m v_2^2$$

$$\text{Loss of KE, } \Delta K = K_i - K_f = \frac{1}{2} m u_1^2 - \frac{1}{2} m v_2^2$$

$$\text{According to question, } \frac{1}{2} \left(\frac{1}{2} m u_1^2 \right) = \frac{1}{2} m u_1^2 - \frac{1}{2} m v_2^2$$

($\because$ half of its KE is lost by impact)

$$\text{or } u_1^2 = 2v_2^2 \text{ or } v_2 = \frac{u_1}{\sqrt{2}}$$

$$\therefore \text{Coefficient of restitution, } e = \left| \frac{v_2 - v_1}{u_1 - u_2} \right| = \frac{v_2}{u_1} = \frac{1}{\sqrt{2}}$$

37. (b) : When the plane of a coil is perpendicular to the field, the flux linked with the coil is

$$\phi_1 = N B A \cos 0^\circ = N B A$$

When the coil is turned through 180° , the flux linked with the coil is

$$\phi_2 = N B A \cos 180^\circ = -N B A \quad (\because \cos 180^\circ = -1)$$

$\therefore$ Change in flux,

$$\Delta \phi = \phi_2 - \phi_1 = -N B A - N B A = -2N B A$$

$$\therefore |\Delta \phi| = 2N B A$$

Magnitude of average emf induced is

$$\begin{aligned} |\epsilon_{av}| &= \frac{|\Delta \phi|}{\Delta t} = \frac{2N B A}{\Delta t} \\ &= \frac{2 \times 1000 \times 2 \times 10^{-5} \times 500 \times 10^{-4}}{0.2} \text{ V} \\ &= 10 \times 10^{-3} \text{ V} = 10 \text{ mV} \end{aligned}$$

38. (a) : Since there is no external force acting on the

$$\text{particle, hence } Y_{CM} = \frac{m_1 y_1 + m_2 y_2}{m_1 + m_2} = 0$$

$$\therefore \left(\frac{m}{4} \right) (+15) + \left(\frac{3m}{4} \right) (y_2) = 0 \text{ or } y_2 = -5 \text{ cm}$$

39. (a) : Here, $\eta = 80\%$, $P_i = 4 \text{ kW} = 4000 \text{ W}$

$$V_p = 100 \text{ V}, V_s = 200 \text{ V}, I_p = \frac{P_i}{V_p} = \frac{4000}{100} = 40 \text{ A}$$

$$\text{As } \eta = \frac{V_s I_s}{V_p I_p}; \frac{80}{100} = \frac{200 I_s}{4000} = \frac{I_s}{20}$$

$$\text{or } I_s = \frac{20 \times 80}{100} = 16 \text{ A}$$

40. (a) : When the planet revolves around the sun, its areal velocity remains constant.

$$\therefore \frac{A_1}{t_1} = \frac{A_2}{t_2} = \frac{A_3}{t_3}; \frac{A_1}{2} = \frac{A_2}{3} = \frac{A_3}{6} \text{ or } 3A_1 = 2A_2 = A_3$$

41. (d) : According to their wavelength, the correct order of given electromagnetic waves is

Gamma rays < Micro waves < FM radio waves < AM radio waves

$$\text{42. (b) : Capillary rise, } h = \frac{2T \cos \theta}{r \rho g}$$

For given value of T and r , $h \propto \frac{\cos \theta}{\rho}$

$$\text{Also, } h_1 = h_2 = h_3 \text{ or, } \frac{\cos \theta_1}{\rho_1} = \frac{\cos \theta_2}{\rho_2} = \frac{\cos \theta_3}{\rho_3}$$

Since, $\rho_1 > \rho_2 > \rho_3$, so for positive value of $\cos \theta$, $\cos \theta_1 > \cos \theta_2 > \cos \theta_3$

For $0 \leq \theta < \pi/2$, $\theta_1 < \theta_2 < \theta_3$

Hence, option is (b) i.e. $0 \leq \theta_1 < \theta_2 < \theta_3 < \pi/2$



COMIC CAPSULE

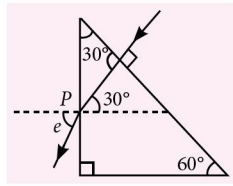
What happens if someone slaps you at a high frequency?
It Hertz.

43. (b) : Let $\angle e$ is angle of emergence and $\angle i$ is angle of incidence.

Form Snell's law at point P

$$\frac{\sin i}{\sin r} = \frac{\mu_a}{\mu_g}; \angle i = 30^\circ$$

$$\text{So, } \frac{\sin 30^\circ}{\sin e} = \frac{\mu_a}{\mu_g}, \sin e = \frac{\sqrt{3}}{1} \times \frac{1}{2} \text{ or } e = 60^\circ$$



44. (d) : As gas bubble is moving upward with constant speed so Buoyant force = Viscous drag force

$$\Rightarrow F_b = F_v$$

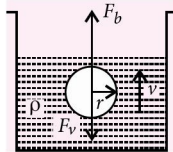
$$\Rightarrow \left(\frac{4}{3} \pi r^3 \right) \rho g = 6\pi\eta r v$$

$$\Rightarrow \eta = \frac{2}{9} \frac{r^2 \rho g}{v}$$

Here, $r = 1 \text{ cm}$, $\rho = 1.75 \text{ g cm}^{-3}$, $g = 980 \text{ cm s}^{-2}$

$v = 0.35 \text{ cm s}^{-1}$, $\eta = ?$

$$\therefore \eta = \frac{2}{9} \times \frac{1^2 \times 1.75 \times 980}{0.35} = 1088.88 \approx 1089 \text{ poise}$$



45. (b) : Here, $\frac{I_1}{I_2} = n$

$$\frac{I_{\max}}{I_{\min}} = \left(\frac{\sqrt{I_1} + \sqrt{I_2}}{\sqrt{I_1} - \sqrt{I_2}} \right)^2 = \left(\frac{\sqrt{I_1/I_2} + 1}{\sqrt{I_1/I_2} - 1} \right)^2 = \left(\frac{\sqrt{n} + 1}{\sqrt{n} - 1} \right)^2$$

$$\frac{I_{\max} - I_{\min}}{I_{\max} + I_{\min}} = \frac{\frac{I_{\max}}{I_{\min}} - 1}{\frac{I_{\max}}{I_{\min}} + 1} = \frac{\left(\frac{\sqrt{n} + 1}{\sqrt{n} - 1} \right)^2 - 1}{\left(\frac{\sqrt{n} + 1}{\sqrt{n} - 1} \right)^2 + 1}$$

$$= \frac{(\sqrt{n} + 1)^2 - (\sqrt{n} - 1)^2}{(\sqrt{n} + 1)^2 + (\sqrt{n} - 1)^2} = \frac{4\sqrt{n}}{2(n+1)} = \frac{2\sqrt{n}}{n+1}$$

46. (a) : Let x be thickness of each wooden plank.

If u is the initial speed with which the bullet is fired from rifle, then its speed after passing through one wooden plank is

$$v = u - \frac{20}{100} u = u - \frac{1}{5} u = \frac{4}{5} u$$

As $v^2 - u^2 = 2as$

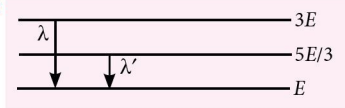
$$\therefore \left(\frac{4}{5} u \right)^2 - u^2 = 2ax \text{ or } 2ax = -\frac{9}{25} u^2 \quad \dots(i)$$

If n is the minimum number of wooden planks required to stop the bullet, i.e. $v = 0$ $\therefore (0)^2 - u^2 = 2a(nx)$

$$\text{or } n = \frac{-u^2}{2ax} = \frac{-u^2}{\left(-\frac{9}{25} u^2 \right)} = \frac{25}{9} = 2.78 \quad (\text{using (i)})$$

As n can't be fraction, $\therefore n = 3$

47. (a) :



From figure,

$$\frac{hc}{\lambda} = 3E - E = 2E \quad \dots(i); \quad \frac{hc}{\lambda'} = \frac{5E}{3} - E = \frac{2}{3} E \quad \dots(ii)$$

Divide (i) by (ii), we get $\frac{\lambda'}{\lambda} = 3$ or $\lambda' = 3\lambda$

48. (a) : Suppose the final temperature of the mixture be 100°C .

Heat required by ice to convert totally into water at 100°C ,

$$Q_1 = 1 \times 80 + 1 \times 1 \times 100 = 180 \text{ cal}$$

Heat supplied by steam if it was to condense totally and convert into water at 100°C ,

$$Q_2 = 1 \times 540 = 540 \text{ cal}$$

As $Q_2 > Q_1$, hence whole of steam will not condense.

Let m be the mass of steam which condenses into water at 100°C .

$$\text{Then } m \times 540 = 180 \text{ or } m = \frac{180}{540} \text{ g} = \frac{1}{3} \text{ g}$$

$$\therefore \text{Amount of water in the mixture} = 1 \text{ g} + \frac{1}{3} \text{ g} = \frac{4}{3} \text{ g}$$

49. (c) : de Broglie wavelength associated with an electron (mass m , charge e) accelerated from rest with a

voltage V volt is $\lambda = \frac{h}{\sqrt{2meV}}$ or $\lambda \propto \frac{1}{\sqrt{V}}$

$$\therefore \lambda_1 : \lambda_2 : \lambda_3 = \frac{1}{\sqrt{V_1}} : \frac{1}{\sqrt{V_2}} : \frac{1}{\sqrt{V_3}}$$

$$= \frac{1}{\sqrt{100 \text{ V}}} : \frac{1}{\sqrt{200 \text{ V}}} : \frac{1}{\sqrt{300 \text{ V}}} = 1 : \frac{1}{\sqrt{2}} : \frac{1}{\sqrt{3}}$$

$$\text{50. (c) : } X = \frac{A^2 B^{1/2}}{C^{1/3} D^3}$$

Maximum percentage error in X

$$\left(\frac{dX}{X} \right) \times 100 = \left(2 \frac{dA}{A} + \frac{1}{2} \frac{dB}{B} + \frac{1}{3} \frac{dC}{C} + 3 \frac{dD}{D} \right) \times 100$$

$$= 2 \times 1 + \frac{1}{2} \times 2 + \frac{1}{3} \times 3 + 3 \times 4 = 16\%$$



Success Guaranteed in CUET (UG)

Common University Entrance Test Under-Graduate Programmes
with **MTG CUET (UG) Practice Papers**

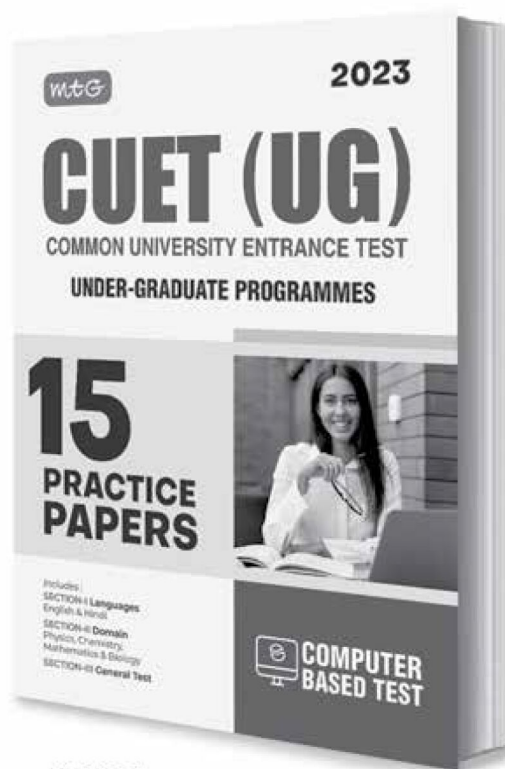
From the academic session 2022-23, admissions to Undergraduate Programmes in all central universities in the country will take place through Central University Entrance Test (CUET).

To help students with their preparation for the above test MTG is coming up with the book CUET 2023 which caters the Science Stream for the test. The MTG CUET (UG) – 2023 title covers 15 Practice papers which include following subjects in each practice paper :

Section IA Languages : English and Hindi

Section II Domain : Physics, Chemistry, Mathematics and Biology

Section III General Test : General Knowledge, Current Affairs, General Mental Ability, Numerical Ability, Quantitative Reasoning, Logical and Analytical Reasoning



₹ 800/-



Available at all leading book shops throughout the country.
For more information or for help in placing your order:
Visit www.mtg.in to buy online!
Call 0124-6601200 or e-mail: info@mtg.in

Visit
www.mtg.in
for latest offers
and to buy
online!

CHAPTERWISE PRACTICE PAPER 2023

CUET (UG)

Exam on
21st to 31st
May 2023

SERIES - VII Modern Physics

Section II of CUET (UG) is Domain specific. In this section of Physics, 35 questions to be attempted out of 45.

SECTION-A

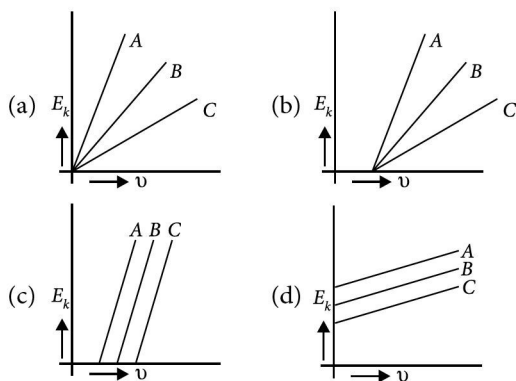
(All questions are compulsory.)

- The ratio of wavelengths of the last line of Balmer series and the last line of Lyman series is
(a) 1 (b) 4 (c) 0.5 (d) 2
- The momentum of a photon of an electromagnetic radiation is $3.3 \times 10^{-29} \text{ kg m s}^{-1}$. What is the frequency of the associated waves?
[$h = 6.6 \times 10^{-34} \text{ J s}$; $c = 3 \times 10^8 \text{ m s}^{-1}$]
(a) $1.5 \times 10^{13} \text{ Hz}$ (b) $7.5 \times 10^{12} \text{ Hz}$
(c) $6 \times 10^3 \text{ Hz}$ (d) $3 \times 10^3 \text{ Hz}$
- The half life of an old rock element is 5800 years. In how many years its sample of 25 g is reduced to 6.25 g?
(a) 2900 years (b) 5800 years
(c) 11600 years (d) 23200 years
- Statement I:** The phenomenon of X-ray production is basically inverse of photoelectric effect.
Statement II: X-rays are electromagnetic waves.
(a) Both Statement I and Statement II are true and Statement II is the correct explanation of Statement I.
(b) Both Statement I and Statement II are true but Statement II is not the correct explanation of Statement I.
(c) Statement I is true but Statement II is false.
(d) Both Statement I and Statement II are false.
- In terms of Bohr radius a_0 , the radius of the second Bohr orbit of a hydrogen atom is given by
(a) $4a_0$ (b) $8a_0$ (c) $\sqrt{2}a_0$ (d) $2a_0$
- Energy released in the fission of a single ${}_{92}^{235}\text{U}$ nucleus is 200 MeV. The fission rate of ${}_{92}^{235}\text{U}$ filled reactor operating at a power level of 5 W is
(a) $1.56 \times 10^{-10} \text{ s}^{-1}$ (b) $1.56 \times 10^{11} \text{ s}^{-1}$
(c) $1.56 \times 10^{-16} \text{ s}^{-1}$ (d) $1.56 \times 10^{-17} \text{ s}^{-1}$
- The De-Broglie wavelength of electron in third orbit of He^{+1} ion is approximately
(a) 2 Å (b) 3 Å (c) 4 Å (d) 5 Å
- A photocell with a constant potential difference of V volt across it is illuminated by a point source from a distance of 25 cm. When the source is moved to a distance of 1 m, the electrons emitted by the photocell
(a) carry 1/4th their previous energy.
(b) are 1/16th as numerous as before.
(c) are 1/4th as numerous as before.
(d) carry 1/4th their previous momentum.
- The collector plate in an experiment on photoelectric effect is kept vertically above the emitter plate. Light source is put on and a saturation photoelectric current is recorded. Now an electric field is switched on which has a vertically downward direction, then
I. the photoelectric current will increase
II. the kinetic energy of the electrons will increase
III. the threshold wavelength will increase
IV. the stopping potential will decrease
V. there is no change in collector potential.
Read the given statements and select the correct option.
(a) I and IV are correct. (b) II and V are correct.
(c) I and V are correct. (d) II and III are correct.
- Consider 3rd orbit of He^{+} (Helium), using non-relativistic approach, the speed of electron in this orbit will be (given $K = 9 \times 10^9$, $Z = 2$ and h (Planck's constant) = $6.6 \times 10^{-34} \text{ J s}$)
(a) $2.92 \times 10^6 \text{ m/s}$ (b) $1.46 \times 10^6 \text{ m/s}$
(c) $0.73 \times 10^6 \text{ m/s}$ (d) $3.0 \times 10^8 \text{ m/s}$

11. Match List-I (Fundamental Experiment) with List-II (its conclusion) and select the correct option from the choices given below the list:

List-I		List-II	
P.	Franck-Hertz Experiment.	(i)	Particle nature of light
Q.	Photo-electric Experiment.	(ii)	Discrete energy levels of atom
R.	Davison-Germer Experiment.	(iii)	Wave nature of electron
		(iv)	Structure of atom

- (a) P - (ii), Q - (i), R - (iii)
 (b) P - (iv), Q - (iii), R - (ii)
 (c) P - (i), Q - (iv), R - (iii)
 (d) P - (ii), Q - (iv), R - (iii)
12. The size of nucleus is directly proportional to
 (a) mass number (A) of the atom.
 (b) square root of the mass number (A) of the atom.
 (c) cube root of mass number (A) of atom.
 (d) square of mass number of atom.
13. For three different metals A , B and C photoemission is observed one by one and E_k vs ν is plotted. Which one of the following represents this curve correctly?



14. Match List I of the nuclear processes with List II containing parent nucleus and one of the end products of each process and then select the correct answer using the codes given below the lists :

List I	List II
P. Alpha decay	1. $^{15}_8\text{O} \rightarrow ^{15}_7\text{N} + \dots$
Q. β^+ decay	2. $^{238}_{92}\text{U} \rightarrow ^{234}_{90}\text{Th} + \dots$
R. Fission	3. $^{185}_{83}\text{Bi} \rightarrow ^{184}_{82}\text{Pb} + \dots$
S. Proton emission	4. $^{239}_{94}\text{Pu} \rightarrow ^{140}_{57}\text{La} + \dots$

Codes :

	P	Q	R	S
(a)	4	2	1	3
(b)	1	3	2	4
(c)	2	1	4	3
(d)	4	3	2	1

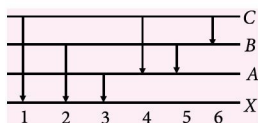
15. The current in a photocell can be just reduced to zero by a potential of 2.5 V. The maximum kinetic energy of the emitted electrons is
 (a) 2 eV (b) 2.5 eV (c) 1.4 eV (d) 2.8 eV

SECTION-B

(Attempt any 20 questions.)

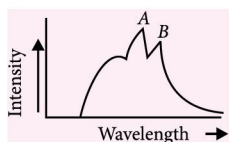
16. A proton and an α -particle are accelerated through the same potential difference. The ratio of de-Broglie wavelength of the proton to that of the α -particle will be
 (a) 2 : 1 (b) 1 : 1 (c) 1 : 2 (d) 1 : $2\sqrt{2}$
17. The total energy E of the electron in a hydrogen atom is
 (a) $\frac{-e^2}{8\pi\epsilon_0 r}$ (b) $\frac{-e^2}{4\pi\epsilon_0 r}$ (c) $\frac{-e^2}{2\pi\epsilon_0 r}$ (d) $\frac{-e^2}{\pi\epsilon_0 r}$
18. **Statement I:** Photoelectric emission is an instantaneous process.
Statement II: There is no time lag between incidence of light and emission of photoelectrons.
 (a) Both Statement I and Statement II are true and Statement II is the correct explanation of Statement I.
 (b) Both Statement I and Statement II are true but Statement II is not the correct explanation of Statement I.
 (c) Statement I is true but Statement II is false.
 (d) Both Statement I and Statement II are false.
19. **Statement I:** Rydberg's constant varies with the mass number of a given element.
Statement II: The reduced mass of the electron depends on the mass of the nucleus only.
 (a) Both Statement I and Statement II are true and Statement II is the correct explanation of Statement I.
 (b) Both Statement I and Statement II are true but Statement II is not the correct explanation of Statement I.
 (c) Statement I is true but Statement II is false.
 (d) Both Statement I and Statement II are false.

20. The figure indicates the energy level diagram of an atom and the origin of six spectral lines in emission (e.g., line no. 5 arises from the transition from level B to A).



Which of the following spectral lines will occur in the absorption spectrum?

- (a) 4, 5, 6 (b) 1, 2, 3, 4, 5, 6
(c) 1, 2, 3 (d) 1, 4, 6
21. The De-Broglie wavelength of an electron of speed 0.5 km s^{-1} is
(a) $1.5 \times 10^{-6} \text{ m}$ (b) $1.5 \times 10^{-8} \text{ m}$
(c) $1.5 \times 10^{-10} \text{ m}$ (d) $1.5 \times 10^{-12} \text{ m}$
22. The radius of the innermost electron orbit of a hydrogen atom is a . What are the radii of the $n = 2$ and $n = 3$ orbits?
(a) $2a_0$ and $3a_0$ (b) $4a_0$ and $6a_0$
(c) $4a_0$ and $9a_0$ (d) $5a_0$ and $7a_0$
23. The figure represents the observed intensity of X-rays emitted by an X-ray tube, I as a function of wavelength. The sharp peaks A and B denote
(a) white radiations (b) characteristic radiations
(c) band spectrum (d) continuous spectrum
24. When the intensity of a light source is increased
I. the number of photons emitted by the source in unit time increases.
II. the total energy of the photons emitted per unit time increases.
III. more energetic photons are emitted.
IV. faster photons are emitted.
V. there is a change in wavelength of light.
Select the correct option.
(a) I, II and III are correct
(b) II and III are correct
(c) I and II are correct
(d) III and IV are correct



25. In Millikan's oil drop experiment, an oil drop of radius r and charge Q is held in equilibrium between the plates of a charged parallel plate capacitor when the potential difference is V . To keep a drop of radius $2r$ and charge $2Q$ in equilibrium between the plates, the potential difference V' required is
(a) $8V$ (b) $4V$ (c) $2V$ (d) V



PUBLIC NOTICE

CUET 2023

National Testing Agency has been mandated by the **Ministry of Education and UGC** to conduct Common University Entrance Test (CUET) for admission into **Undergraduate Programmes** in **Central Universities** under Ministry of Education, and other participating Universities / Institutions / Organizations / Autonomous Colleges.

CUET (UG) will provide a **single window opportunity** to students seeking admission in any of the Central Universities (CUs) or other participating organizations (including State Universities, Deemed and Private Universities) across the Country.

For the Academic Session 2023-24, CUET (UG) – 2023 will be conducted in the **Computer Based Test (CBT) mode** as per the details given below :

Online Submission of Application Form	09 February to 12 March 2023 (Up to 09:00 P.M.)
Last date of successful transaction of fee through Credit / Debit Card / Net-Banking / UPI	12 March 2023 (up to 11:50 P.M.)
Correction in Particulars	15 March to 18 March 2023 (Up to 11:50 P.M.)
Announcement of the City of Examination	30 April 2023
Downloading of Admit Cards from the NTA website	Second week of the May 2023
Date of Examination	21 May 2023 onwards
Display of Recorded Responses and Answer Keys	To be announced later on the website
Website(s)	www.nta.ac.in , https://cuet.samarth.ac.in/
Declaration of Result on the NTA website	To be announced later on the website

The details of the programmes offered by Central Universities (CUs) and other participating Universities / Organizations are available on their respective websites as well as on <https://cuet.samarth.ac.in/>. **Candidates must carefully refer to the eligibility requirements of the programmes offered by various Central Universities and participating Universities / Organizations in this regard.**

The CUET (UG) – 2023 will be conducted in **13 languages** i.e. English, Hindi, Assamese, Bengali, Gujarati, Kannada, Malayalam, Marathi, Odia, Punjabi, Tamil, Telugu, and Urdu.

For CUET (UG) – 2023, the following is the scheme of examination :

Section	Subjects/ Tests	Questions to be Attempted
Section 1A - Languages	There are 13 different languages. Any of these languages may be chosen.	40 questions to be attempted out of 50 in each language
Section 1B - Languages	There are 20 Languages. Any of these languages may be chosen.	
Section 2 - Domain Specific Subject	There are 27 Domain specific subjects being offered under this section. A candidate may choose any subject as desired by the applicable University/ Organization.	35/40 Questions to be attempted out of 45/50
Section 3 - General Test	For any such undergraduate programme / programmes being offered by Universities where a General Test is being used for admission.	50 Questions to be attempted out of 60

Note:

- From the above subjects / languages, the candidate can choose maximum of 10 subjects from all three Section.
- Examination will be conducted on multiple days in three shifts, depending on the number of Candidates and Subject choices.

In case any candidate faces difficulty in applying for CUET (UG) – 2023, he/she may contact 011 - 40759000 / 011 - 69227700 or e-mail at cuet-ug@nta.ac.in. The candidates are also advised to be in touch with the NTA website(s) www.nta.ac.in and <https://cuet.samarth.ac.in/> for the latest updates regarding the exam.

26. A 12.5 eV electron beam is used to bombard gaseous hydrogen at room temperature. What series of spectral lines will be emitted ?

- (a) 1 Lyman, 2 Balmer
(b) 2 Lyman, 1 Balmer
(c) 1 Lyman, 1 Balmer, 1 Paschen
(d) 3 Balmer

27. Match the following table.

Column-I		Column-II	
(A)	Nuclear fission	(P)	Converts some matter into energy
(B)	Nuclear fusion	(Q)	Possible for nuclei with low atomic number
(C)	β -decay	(R)	Possible for nuclei with high atomic number
(D)	Exothermic nuclear reaction	(S)	Essentially proceeds by weak nuclear forces.

- (a) (A) $\rightarrow$ P, R; (B) $\rightarrow$ P, Q; (C) $\rightarrow$ P, Q, R; (D) $\rightarrow$ P, Q, S
(b) (A) $\rightarrow$ P, Q; (B) $\rightarrow$ P, R; (C) $\rightarrow$ P, Q, R, S; (D) $\rightarrow$ P, Q, R
(c) (A) $\rightarrow$ P, R; (B) $\rightarrow$ P, Q; (C) $\rightarrow$ P, Q, R, S; (D) $\rightarrow$ P, Q, R
(d) (A) $\rightarrow$ P, R; (B) $\rightarrow$ P, Q; (C) $\rightarrow$ P, Q, S; (D) $\rightarrow$ P, R, S

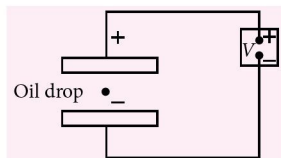
28. Let T_1 and T_2 be the energy of an electron in the first and second excited states of hydrogen atom, respectively. According to the Bohr's model of an atom, the ratio $T_1 : T_2$ is

- (a) 1 : 4 (b) 4 : 1 (c) 4 : 9 (d) 9 : 4

29. The diagram shows a charged oil drop between two horizontal plates connected to a high voltage source V . Which of the following statements is/are correct?

- If the drop is stationary, then it must carry a positive charge.
- If the drop is falling at terminal velocity, then a resultant force must be acting on it.
- If the drop is stationary and then it suddenly starts to rise, then it must have gained extra electrons.

- (a) 1 only
(b) 2 only
(c) 3 only
(d) 1 and 2 only



30. One of the following is not used as a moderator in a nuclear reactor,

- (a) H_2O (b) D_2O
(c) Graphite (d) Cadmium

31. A nucleus of mass number 189 splits into two nuclei having mass number 125 and 64. The ratio of radius of two daughter nuclei respectively is

- (a) 1 : 1 (b) 4 : 5
(c) 5 : 4 (d) 25 : 16

32. λ is proportional to

- (a) $1/E$ for both photons and particles.
(b) $1/E$ for photons; $1/\sqrt{E}$ for particles.
(c) $1/\sqrt{E}$ for both photons and particles.
(d) $1/\sqrt{E}$ for photons; $1/E$ for particles.

33. For the transformation of ${}_Z^A X$ into a nucleus ${}_{Z-2}^{A-4} Y$, the Q-value can be expressed as,

- (a) $Q = (m_X - m_Y)c^2$ (b) $Q = (m_X - m_Y - m_{He})c^2$
(c) $Q = (m_Y - m_X)c^2$ (d) $Q = (m_Y + m_{He} - m_X)c^2$

34. Threshold wavelength for a metal is 5200 Å. Photoelectrons will be ejected, if it is irradiated by a light from

- (a) 50 watt infrared lamp
(b) 1 watt infrared lamp
(c) 50 watt ultraviolet lamp
(d) 0.5 watt infrared lamp

35. Match the corresponding entire of Column I with Column II.

Column I		Column II	
(A)	Sun	(P)	Nuclear fission
(B)	Nuclear reactor	(Q)	Nuclear fusion
(C)	Total binding energy in a process is increased	(R)	Energy is released
(D)	Total binding energy in a process is decreased	(S)	Energy is absorbed

- (a) (A) $\rightarrow$ R; (B) $\rightarrow$ Q; (C) $\rightarrow$ S; (D) $\rightarrow$ P, R
(b) (A) $\rightarrow$ P, Q; (B) $\rightarrow$ Q, S; (C) $\rightarrow$ (R); (D) $\rightarrow$ P
(c) (A) $\rightarrow$ P; (B) $\rightarrow$ Q; (C) $\rightarrow$ R; (D) $\rightarrow$ P, S
(d) (A) $\rightarrow$ Q, R; (B) $\rightarrow$ P, R; (C) $\rightarrow$ P, Q, R; (D) $\rightarrow$ S

UNSCRAMBLED WORDS

FEBRUARY 2023

- 1-g- RESISTANCE 2-h- GALVANOMETER
3-e- ISOTHERMAL 4-b- DIMENSIONS
5-j- ISOMERS 6-c- ACCELERATION
7-a- CANDELA 8-i- HALF LIFE
9-f- FREQUENCY 10-d- IMPULSE

Winner : Tanushree (West Bengal)

CASE BASED MCQs

Case I : Read the passage given below and answer the following questions from 36 to 40.

It is found that mass of the nucleus is less than the total mass of protons and neutrons, this mass difference is called mass defect. Nuclear binding energy is the energy equivalence to the mass defect. Thus, mass defect is in the form of energy and is responsible for binding the nucleons together. Binding energy per nucleon is another quantity which is very useful in predicting the stability of a nucleus.

36. Li nucleus has three protons and four neutrons. Mass of Li nucleus is 7.016005 amu. Mass of proton is 1.007277 amu and mass of neutron is 1.008665 amu. Mass defect of lithium nucleus (in amu) is
(a) 0.04048 (b) 0.04050
(c) 0.04052 (d) 0.04055
37. If M_O is the mass of an oxygen isotope ${}_8\text{O}^{17}$, M_p and M_N are the masses of a proton and a neutron respectively, the nuclear binding energy of the isotope is
(a) $(M_O - 17 M_N)c^2$ (b) $(M_O - 8 M_p)c^2$
(c) $(8M_p + 9M_N - M_O)c^2$ (d) $M_O c^2$
38. If the binding energies of a deuteron and an alpha particle are 1.125 MeV and 7.2 MeV respectively, then the more stable of the two is
(a) deuteron (b) alpha particle
(c) both (a) and (b)
(d) sometimes deuteron and sometimes alpha particle
39. The mass defect of ${}_2^4\text{He}$ is 0.03 u. The binding energy per nucleon of helium (in MeV) is
(a) 69.825 (b) 6.9825 (c) 2.793 (d) 27.93
40. The ratio of mass defect of the nucleus to its mass number is maximum for
(a) U^{238} (b) N^{14} (c) Si^{28} (d) Fe^{56}

Case II : Read the passage given below and answer the following questions from 41 to 45.

The energy required to remove an electron completely from its parent atom, is called ionisation energy. In ground state, ($n = 1$) energy of atom is -13.6 eV and energy corresponding to $n = \infty$ is zero. Similarly, the potential difference through which energy transitions take place is called ionisation potential.

41. As per Bohr model, the minimum energy in eV, required to remove an electron from the ground state of doubly ionised Li atom ($Z = 3$) is
(a) 122.4 (b) 13.6 (c) 40.8 (d) 1.51
42. The energy required to knockout the electron in the third orbit of an atom is equal to
(a) $+\frac{13.6}{9}$ eV (b) $+\frac{13.6}{3}$ eV
(c) $-\frac{13.6}{9}$ eV (d) $-\frac{13.6}{3}$ eV
43. The energy (in eV) required to remove an electron in a hydrogen atom from $n = 10$ state is
(a) 136.0 (b) 13.60 (c) 1.36 (d) 0.136
44. The ionisation energy of 10 times ionised sodium atom is
(a) $13.6 \times (11)^3$ eV (b) 13.6×11 eV
(c) $13.6 \times (11)^4$ eV (d) $13.6 \times (11)^2$ eV
45. According to Bohr's theory, the angular momentum for an electron of 5th orbit is
(a) $2.5 h/\pi$ (b) $5 h/\pi$ (c) $25 h/\pi$ (d) $6 h/2\pi$

SOLUTIONS

1. (b): The wavelength of last line of Balmer series

$$\frac{1}{\lambda_L} = R \left(\frac{1}{2^2} - \frac{1}{\infty^2} \right) = \frac{R}{4}$$

The wavelength of last line of Lyman series

$$\frac{1}{\lambda_L} = R \left(\frac{1}{1^2} - \frac{1}{\infty^2} \right) = R \therefore \frac{\lambda_B}{\lambda_L} = \frac{4}{1} = 4$$

2. (a): Momentum of the photon = $\frac{h\nu}{c}$

$$\Rightarrow \frac{c}{\nu} = \frac{h}{p} = \lambda$$

$$\nu = \frac{c}{\lambda} = \frac{cp}{h} = 3 \times 10^8 \times \frac{3.3 \times 10^{-29}}{6.6 \times 10^{-34}} = 1.5 \times 10^{13} \text{ Hz}$$

3. (c): Here, Half life, $T_{1/2} = 5800$ years

Amount of sample left after n half lives is

$$N = N_0 \left(\frac{1}{2} \right)^n; \frac{N}{N_0} = \left(\frac{1}{2} \right)^n \Rightarrow \frac{6.25 \text{ gm}}{25 \text{ gm}} = \left(\frac{1}{2} \right)^n$$

$$\frac{1}{4} = \left(\frac{1}{2} \right)^n \Rightarrow n = 2$$

$$\therefore t = n T_{1/2} = 2 \times 5800 \text{ years} = 11600 \text{ years}$$

4. (b): In photoelectric effect, the photon falling on some matter is absorbed by the matter and its energy is transferred to an electron of the matter. In X-ray production, photons are produced which get energy from energetic electrons ionising the inner shells of the target which in turn cause a cascade of emission lines.

5. (a): As $r \propto n^2$, therefore, radius of 2nd Bohr's orbit = $4a_0$

6. (b): Fission rate

$$= \frac{\text{total power}}{\text{energy fission}} = \frac{5}{200 \times 1.6 \times 10^{-13}} = 1.56 \times 10^{11} \text{ s}^{-1}$$

7. (d): $2\pi r = n\lambda$

$$\lambda = \frac{2\pi r}{n} = \frac{2\pi \times (0.529 \text{ \AA}) \frac{n^2}{Z}}{n}$$

$$\lambda = 2\pi \times (0.529 \text{ \AA}) \frac{n}{Z} = 2\pi \times 0.529 \text{ \AA} \times \frac{3}{2}$$

$$\lambda = 3\pi \times 0.529 \text{ \AA} \approx 5 \text{ \AA}$$

8. (b): Photoelectric current I is directly proportional

$$\text{to intensity of light and intensity} \propto \frac{1}{(\text{distance})^2} \Rightarrow I \propto \frac{1}{r^2}$$

$$I_{25} \propto \frac{1}{(25)^2} \quad \dots(i)$$

$$I_{100} \propto \frac{1}{(100)^2} \quad (\because 1\text{m} = 100\text{cm}) \quad \dots(ii)$$

$$\therefore \frac{I_{25}}{I_{100}} = \frac{(100)^2}{(25)^2} = 16 \Rightarrow I_{100} = \frac{I_{25}}{16}$$

9. (b)

10. (b): Energy of electron in the 3rd orbit of He^+ is

$$E_3 = -13.6 \times \frac{Z^2}{n^2} \text{ eV} = -13.6 \times \frac{4}{3^2} \text{ eV}$$

$$= -13.6 \times \frac{4}{9} \times 1.6 \times 10^{-19} \text{ J}$$

$$\text{From Bohr's model, } E_3 = -KE_3 = -\frac{1}{2} m_e v^2$$

$$\Rightarrow \frac{1}{2} \times 9.1 \times 10^{-31} \times v^2 = -13.6 \times \frac{4}{9} \times 1.6 \times 10^{-19}$$

$$\Rightarrow v^2 = \frac{136 \times 16 \times 4 \times 2 \times 10^{-11}}{9 \times 91}$$

$$\text{or } v = 1.46 \times 10^6 \text{ m s}^{-1}$$

11. (a): Franck-Hertz Experiment - Discrete energy levels of atom. Photo-electric experiment - Particle nature of light.

Davison-Germer Experiment - Wave nature of electron.

12. (c)

13. (c)

14. (c)

15. (b): Maximum K.E. = $eV_s = e \times 2.5 = 2.5 \text{ eV}$

16. (d): Gain in KE = Loss in PE, $\frac{p^2}{2m} = qV$

$$p = \sqrt{2mqV}$$

$$\frac{p_p}{p_\alpha} = \frac{\sqrt{2m_p(e)V}}{\sqrt{2m_\alpha(2e)V}} = \sqrt{\frac{m_p}{m_\alpha} \left(\frac{e}{2e} \right)} = \sqrt{\frac{1}{4} \cdot \frac{1}{2}} = \frac{1}{2\sqrt{2}}$$

$$\text{since } \lambda = \frac{h}{p} \Rightarrow \frac{\lambda_p}{\lambda_\alpha} = \frac{p_\alpha}{p_p} = \frac{2\sqrt{2}}{1}$$

17. (a): For an electron in a H-atom, $F_e = F_c$

$$\frac{1}{4\pi\epsilon_0} \frac{e^2}{r^2} = \frac{mv^2}{r}; r = \frac{e^2}{4\pi\epsilon_0 mv^2}$$

$$\text{As } K = \frac{1}{2} mv^2 = \frac{e^2}{8\pi\epsilon_0 r} \text{ and } U = \frac{-e^2}{4\pi\epsilon_0 r}$$

$$\text{As } E = U + K = \frac{-e^2}{4\pi\epsilon_0 r} + \frac{e^2}{8\pi\epsilon_0 r} = \frac{-e^2}{8\pi\epsilon_0 r}$$

18. (a)

19. (d): The Rydberg constant is given by $R = \frac{13.6\text{eV}}{hc}$,

which is independent of the mass number of an element. Reduced mass of the system depends on the masses of both the electron as well as nucleus.

Form IV

- | | |
|---|--|
| 1. Place of Publication | : New Delhi |
| 2. Periodicity of its Publication | : Monthly |
| 3. Printer's Name | : HT Media Ltd. |
| 3a. Publisher's Name | : MTG Learning Media Pvt. Ltd. |
| Nationality | : Indian |
| Address | : 406, Taj Apartment,
New Delhi - 110029 |
| 4. Editor's Name | : Anil Ahlawat |
| Nationality | : Indian |
| Address | : 19, National Media
Centre, Gurugram,
Haryana - 122002 |
| 5. Name and address of individuals who own the newspapers and partners or shareholders holding more than one percent of the total capital | : Mahabir Singh Ahlawat
64, National Media Centre,
Nathupur, Gurugram
: Krishna Devi
64, National Media Centre,
Nathupur, Gurugram
: Anil Ahlawat & Sons
19, National Media Centre,
Nathupur, Gurugram
: Anil Ahlawat
19, National Media Centre,
Nathupur, Gurugram |

I, Mahabir Singh, authorised signatory for MTG Learning Media Pvt. Ltd. hereby declare that particulars given above are true to the best of my knowledge and belief.

For MTG Learning Media Pvt. Ltd.
Mahabir Singh
Director

20. (c): Absorption spectrum involves only excitation of ground level to higher level. Therefore spectral lines 1, 2, 3 will occur in the absorption spectrum.

21. (a): $\lambda = \frac{h}{p} = \frac{h}{mv}$

$$\Rightarrow \lambda = \frac{6.6 \times 10^{-34} \text{ J s}}{(9.1 \times 10^{-31} \text{ kg} \times 500 \text{ ms}^{-1})} = 1.5 \times 10^{-6} \text{ m.}$$

22. (c): $r_n = n^2 a_0, r^2 = 2^2 a_0 = 4a_0, r_3 = 3^2 a_0 = 9a_0.$

23. (b)

24. (c): When the intensity of light source is increased, a large number of photons are emitted from the light source. Hence (I) is correct. Due to increase in the number of photons, total energy of the photons emitted per unit time also increases. Hence statement (II) is correct. Increase in the intensity of light increases only the number of photons, not the energy of the photons. Hence (III) is incorrect. The speed of photon is not affected by the intensity of light. Hence (IV) is incorrect. The wavelength of light will be the same. Hence statement (V) is correct.

25. (b): At equilibrium, $Q.E = mg = \left(\frac{4}{3}\pi r^3\right) \rho.g$

$$\frac{Q.V}{d} = \left(\frac{4}{3}\pi r^3\right) \rho.g \Rightarrow V = \left(\frac{4}{3}\pi r^3\right) \frac{\rho.g.d}{Q}$$

If charge becomes $2Q$ and radius becomes $2r$, then

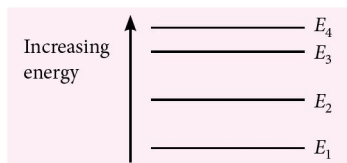
$$V' = \left[\frac{4}{3}\pi(2r)^3\right] \frac{\rho.g.d}{(2Q)} \Rightarrow V' = \left(\frac{2^3}{2}\right)V = 4V$$

26. (b): The hydrogen energy states are -13.6 eV , -3.4 eV , -1.5 eV , -0.85 eV etc.

$$E_3 - E_1 = (-1.5 \text{ eV}) - (-13.6 \text{ eV}) = 12.1 \text{ eV.}$$

$$E_4 - E_1 = (-0.85 \text{ eV}) - (-13.6 \text{ eV}) = 12.75 \text{ eV}$$

so the electron in the ground state can atmost be excited to 3rd level as the available energy with incoming electron is $12.5 \text{ eV} < 12.75 \text{ eV}$. So

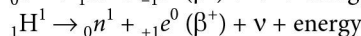
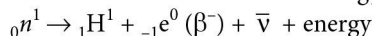


Hence the spectral lines are L_2, L_1 and B_1 as shown.

27. (c): (A) $\rightarrow$ (P, R); (b) $\rightarrow$ (P, Q); (C) $\rightarrow$ (P, Q, R, S); (D) $\rightarrow$ (P, Q, R)

Fission is the process which involves conversion of some matter into energy and shown by atoms of high atomic number such as ${}_{92}\text{U}^{235}$.

Fusion also converts some matter into energy but shown by atoms of low atomic number such as ${}_1\text{H}^1, {}_1\text{H}^2$. β -decay essentially carried out by weak nuclear forces and also converts matter into energy for example



Exothermic nuclear reactions also converts matter into energy and all spontaneous nuclear reaction are exothermic.

28. (d): For 1st excited state, $n = 2$

For 2nd excited state, $n = 3 \therefore \frac{T_1}{T_2} = \frac{n_2^2}{n_1^2} = \frac{3^2}{2^2} = \frac{9}{4}$

29. (c): 1. As E is downwards, the electrostatic force upwards is possible if drop has negative charge.

2. At terminal velocity, acceleration is zero. Hence resultant force is zero.

3. If the drop is stationary and it suddenly starts moving up, then the drop must have gained same negative charge to increase the upward force ($-qE$).

30. (d): In nuclear reactors, light nuclei called moderators are provided along with the fissionable nuclei for slowing down fast neutrons. Moderators commonly used are water, heavy water (D_2O) and graphite. Cadmium, which is a neutron absorbing material is used as a control rod.

31. (c): Nuclear radius, $R = R_0 A^{1/3}$... (i)

where R_0 is a constant and A is the mass number.

From eq. (i) $R \propto A^{1/3}$

$$\frac{R_1}{R_2} = \left(\frac{125}{64}\right)^{1/3} \frac{R_1}{R_2} = \frac{5}{4}$$

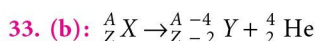
32. (b): $\lambda = \frac{h}{p}$, for photon $E = pc$

$$\Rightarrow \lambda = \frac{h}{E/c} \text{ or } \lambda \propto \frac{1}{E} \text{ for photons.}$$

Further

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mK}} \text{ as } K = \frac{1}{2} mv^2 = \frac{p^2}{2m} \text{ for particles}$$

$$\lambda = \frac{h}{\sqrt{2mE}} \Rightarrow \lambda \propto \frac{1}{\sqrt{E}} \text{ for particles.}$$



The difference between the initial mass energy and the final mass energy of the decay products is called the Q-value or the disintegration energy.

$$\Rightarrow Q = (m_X - m_Y - m_{\text{He}})c^2$$

34. (c): The visible range is approximately from 3500 Å to 7500 Å. The largest wavelengths is red and the shortest is violet. Here $\lambda_0 = 5200$ Å. For photoelectric effect, $\nu > \nu_0$ or $\lambda < \lambda_0$. Here $\lambda < 5200$ Å. Here infrared can't help, but ultraviolet would. The power does not matter.

35. (d): (A) $\rightarrow$ (Q, R); (B) $\rightarrow$ (P, R); (C) $\rightarrow$ (P, Q, R); (D) $\rightarrow$ (S).

36. (a): Here, $m_p = 1.007277$ amu

$$m_n = 1.008665 \text{ amu}, m_{\text{Li}} = 7.016005 \text{ amu}$$

Sum of the masses of three protons and four neutrons

$$= 3m_p + 4m_n = 3 \times 1.007277 + 4 \times 1.008665$$

$$= 3.021831 + 4.03466 = 7.056491 \text{ amu}$$

$$\therefore \text{Mass defect} = 7.056491 - 7.016005 = 0.040486 \text{ amu}$$

37. (c): Binding energy $= [ZM_p + (A - Z)M_n - M_O]c^2$

$$= [8M_p + (17 - 8)M_n - M_O]c^2 = (8M_p + 9M_n - M_O)c^2$$

38. (b): B.E. per nucleon of deuteron

$$= \frac{1.125}{2} = 0.5625 \text{ MeV}$$

$$\text{B.E. per nucleon of alpha particle} = \frac{7.2}{4} = 1.8 \text{ MeV}$$

B.E. per nucleon of alpha particle is more.

Therefore, it is more stable.

39. (b): The mass defect of ${}^4_2\text{He}$, $\Delta m = 0.03$ u

$$\text{The binding energy per nucleon} = \frac{\Delta m \times 931}{A} \text{ MeV}$$

$$= \frac{0.03 \times 931}{4} \text{ MeV} = 6.9825 \text{ MeV}$$

40. (d): The ratio of mass defect of the nucleus to its mass number is maximum for Fe^{56} .

$$41. (a): \text{Energy} = -\frac{13.6Z^2}{n^2} \text{ eV}$$

given $Z = 3, n = 1$

$$\therefore E = -\frac{13.6 \times 9}{(1)^2} = -\frac{13.6 \times 9}{1} \text{ eV}$$

Thus, energy required to knockout the electron is 122.4 eV

$$42. (a): \text{Energy} = \frac{-13.6}{n^2} \cdot z^2 \text{ eV}; Z = 1, n = 3$$

$$E = \frac{-13.6 \times 1}{3^2} = \frac{13.6}{9} \text{ eV}$$

Thus, energy required to knockout the electron is

$$\frac{13.6}{9} \text{ eV}.$$

$$43. (d): \text{Energy} = \frac{13.6}{n^2} = \frac{13.6}{(10)^2} = \frac{13.6}{100} = 0.136 \text{ eV}.$$

44. (d): Ionisation energy = I.E.

$$(\text{I.E. for Na}) = Z^2 \times (\text{I.E. for H}) = (11)^2 \times 13.6 \text{ eV}$$

45. (a): According to Bohr's theory, the angular

momentum of an electron is given as: $mvr = \frac{nh}{2\pi}$

For 5th orbit, $n = 5$.

Putting the value of n in the above equation, we have

$$\text{angular momentum} = \frac{5h}{2\pi} = \frac{2.5h}{\pi}.$$



Your favourite MTG Books/Magazines available in ANDHRA PRADESH at

Padma Book Stall - Anakapalle Ph: 08554-223948, 247077

Sri Gayatri Book Centre - Guntur Ph: 9177439700

Sudhita Book Centre - Kakinada Ph: 0884-2368677, 9848241369

Hanuman Book Centre - Khammam Ph: 08842-230522, 9849374292, 8742230522

New Venkatrama & Co. - Nellore Ph: 0861-2323887

Sri Manikanta Book Centre - Rajah Mundry Ph: 0883-2462507, 6662507, 9247404402

Radiant Book Distributors - Secunderabad Ph: 040-27952151, 65454663, 9885320781

Shraddha Book Depot - Secunderabad Ph: 040-27702686, 8008889379, 7032333364

Shraddha Books & Stationery - Secunderabad Ph: 66335996, 9849451558

Aditya Book Centre - Tirupati Ph: 0877 - 2228653, 9490906115

Sri Lakshmi Book Depot - Warangal
Ph: 08712-2447168, 5592013, 9989330297, 9866635127

Gruhamitra Enterprise - Tirupati Ph: 9393632666, 9290899991

Yogaprabha Book Links - Tirupati Ph: 9966865329

Sai Venkateshwara Book Depot - Vijayawada Ph: 0866-2570309, 9848122879

Ashok Book Centre - Vijayawada Ph: 0866-2472095, 9849082096

Jayadurga Book Centre - Vijayawada Ph: 8121193761

Sri Ganesh Book Centre - Vijayawada
Ph: 0866-2442024, 2442023, 9951412161, 9492682161

Gupta Brothers Books - Vishakhapatnam Ph: 0891-754454, 747580, 668338

JBD Educational Pvt. Ltd. Ph: 0891-6645858, 6666064, 8916636669

Sri Rajeshwari Books Links - Vishakhapatnam Ph: 0891-2541415, 6661718, 9848036014

Himamsu Book Distributors - Vizianagaram Ph: 0891-2541415, 6661718, 9848036014

Visit "MTG IN YOUR CITY" on www.mtg.in to locate nearest book seller OR write to info@mtg.in OR call

0124-6601200 for further assistance.

WORD GRID

Readers are requested to send their responses of word grid. Be the Winner!

Find and encircle the words in the given grid, running in one of the possible directions; horizontal, vertical or diagonal by reading the clues given below.

E	L	E	C	T	R	I	C	U	R	R	E	N	T
L	E	N	G	T	H	E	A	T	H	E	R	M	R
E	N	A	R	S	C	R	E	W	S	S	O	M	E
V	G	A	A	U	G	A	S	A	F	O	R	C	E
E	P	C	A	P	A	C	I	T	A	N	C	E	I
L	H	O	S	E	U	N	I	T	S	A	O	L	S
M	A	S	S	R	S	O	F	S	I	N	N	L	T
S	A	T	C	C	S	T	A	T	I	C	S	O	A
U	L	R	A	O	P	I	N	O	T	E	T	A	N
B	F	E	L	N	R	O	G	U	R	M	A	N	T
S	P	E	E	D	I	N	E	R	Z	F	N	N	I
T	E	A	N	U	N	M	O	M	E	N	T	U	M
R	R	L	S	C	G	E	S	A	R	O	O	M	E
A	M	M	E	T	E	R	T	L	O	T	R	B	A
C	A	A	T	I	N	E	A	I	L	Y	T	R	S
C	N	G	I	V	T	M	T	N	L	P	I	E	U
U	E	N	O	I	E	E	I	E	L	E	O	L	R
R	N	E	X	T	R	M	O	T	I	O	N	L	E
A	T	T	O	Y	A	B	N	I	N	D	A	A	M
C	O	I	L	A	T	E	A	M	E	O	L	R	E
Y	E	S	A	C	U	R	R	E	N	T	O	T	N
Y	S	M	E	R	C	U	Y	S	O	F	T	S	T

Across

- The slope of charge versus potential graph.
- Name the branch of mechanics that deals with the study of objects at rest or in equilibrium.
- A low resistance galvanometer.
- Refractive index is the ratio of _____ to light in vacuum to the medium.
- Name the physical quantity which is conserved during inelastic collision.

Down

- C.G.S electromagnetic unit of magnetic field.
- The condition for LCR series circuit in which power factor is unity.
- Name the crystal which acts as a polariser.
- Name the satellite which has time period of 24 hours and has an equatorial plane.
- The principle involved in the production of ultra high magnetic fields.

*Please send entries of solutions both with words and scanned copy of the grid by 10th of every month.

UCD

Unique Career in Demand

Explore the available Unique Career Options!



Photonic Engineering

Photonics is the study of how light may be used to create energy, detect information, or convey information. Light and pictures are transmitted through hair-thin strands of plastic-coated glass fibre in fibre optics technology. The light in these fibres might be created by lasers, which are beam-like device.

Photonics is a curious field of the physical science of light generation, detection and manipulation. We see things because of the light reflected from objects and reaching our eyes. But allowing us to see is not the only thing that light is useful for. What if it could store information and transfer that information through a thin glass fibre with the storage of 300,000,000 telephone calls. Such functionality comes under Photonics. It is the next generation of technology.

According to the US Bureau of Labor Statistics (BLS), Photonics carriers belong to the Architecture and Engineering Occupational Field. Employment in this sector is expected to grow 6 percent between 2020 and 2030.

After a Photonics degree, you can work in various industries. Some of those industries are as follows:

- Semiconductor Technology Companies
- Colleges and Universities
- Optoelectronics Companies
- R & D Organizations
- Fibre and Integrated Optics Companies
- Networking Companies
- Software Companies

Available Courses

The study of Photonic Engineering is further diversified into the below-enlisted degrees :

- B.Tech (Photonic Engineering)
- Electro-Mechanical Engineering
- Laser Development Engineering
- Photonics Device Engineering
- Research Scientist
- Teacher/Lecturer
- Technical Programme Manager

Eligibility For Undergraduate Courses

Aspiring students should have passed their 10 + 2 examination in science or equivalent qualification in any relevant field from a recognised board.

The candidates should have secured a minimum of 50% aggregate marks or equivalent CGPA at their Intermediate level.

Some of the very reputed universities and institutes conduct an entrance examination for admission.

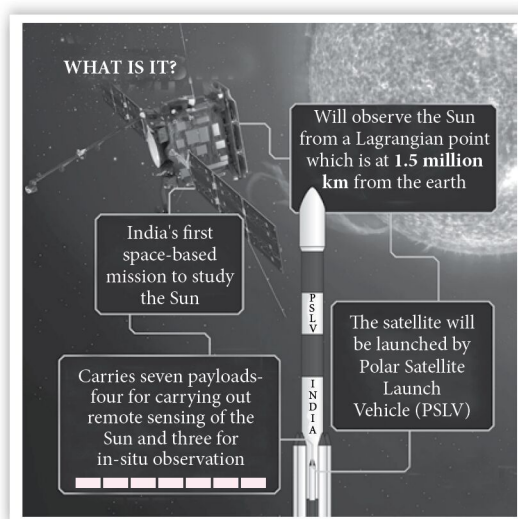
Advanced Courses after B.Tech (Photonic Engineering)

- M.Sc (Photonics)
- M.Tech (Photonics)
- Ph.D.



NATIONAL AND INTERNATIONAL EVENTS

- **World Economic Forum 2023** : The World Economic Forum's (WEF) Annual Meeting for 2023 was held in Davos, Switzerland. It was the 53rd edition of the Annual meeting of the WEF. The theme of this year was 'Cooperation in a Fragmented World'. At the summit, India is represented by a high-level delegation which includes Union Ministers, Chief Ministers, Business leaders, etc.
- **Norovirus** : Recently, Norovirus cases have been detected in Kerala. It is a group of viruses that leads to gastrointestinal illness. It causes inflammation of the lining of the stomach and intestines, in addition to severe vomiting and diarrhoea. Due to this, Norovirus illness is often called by other names, such as food poisoning and stomach flu and "stomach bug."
- **WTO** : Switzerland became the first WTO member to formally submit its acceptance of the WTO's new Agreement on Fisheries Subsidies. The Agreement sets new binding, multilateral rules to curb harmful subsidies, which are a key factor in the widespread depletion of the world's fish stocks. India has one of the lowest fisheries subsidies despite such a large population (\$15 annually per fish family). Also, India's fisheries sector primarily depends on several millions of small-scale and traditional fishers. That is why, India abstain from accepting this agreement.
- **Aditya-L1** : ISRO is planning to launch the Aditya-L1 mission, first Indian space mission to observe the Sun and the solar corona. It will be launched using the Polar Satellite Launch Vehicle (PSLV) with 7 payloads (instruments) on board.



- **Trans-Fat** : A new report from the World Health Organization (WHO) has found that 5 billion people globally remain unprotected from harmful trans fats, increasing their risk of heart disease and death. WHO called for the global elimination of industrially produced trans fats by 2023. Trans-fat, or trans-fatty acids, are most harmful type of unsaturated fatty acids that come from either natural or industrial sources. Industrially produced trans-fat is formed in an industrial process that adds hydrogen to vegetable oil converting the liquid into a solid, resulting in "partially hydrogenated" oil (PHO).
- **Largest moon planet** : The Jupiter moons were added recently to a list kept by the International Astronomical Union's Minor Planet Centre. For the record, Uranus has 27 confirmed moons, Neptune

14, Mars two and Earth one. Venus and Mercury have no moon.

- Captain Shiva Chouhan has become the first-ever woman to be operationally deployed in the world's highest and coldest battlefield, the Siachen Glacier.



- **Helicopter manufacturing unit** : Prime Minister Narendra Modi inaugurated Asia's largest helicopter manufacturing factory of the Hindustan Aeronautics Limited in Tumakuru, Karnataka. This helicopter factory is Asia's largest helicopter manufacturing facility and will initially produce the Light Utility Helicopters (LUH).
- **Birsa Munda International Hockey Stadium** : It is an international field hockey stadium situated at Rourkela, India. The stadium has been named after the tribal leader, Birsa Munda, who was a famous freedom fighter. It is officially recognised by the Guinness World Records as the largest fully seated hockey arena in the world on January 29, 2023.
- **India Science Congress (ISC)** : Recently, the 108th session of the India Science Congress (ISC) was inaugurated by the Prime Minister. The event's theme is 'Science and Technology for Sustainable Development with Women's Empowerment'. Indian Science Congress Association (ISCA) is a premier scientific organisation of India with headquarters at Kolkata, West Bengal. The association started in the year 1914 in Kolkata and it meets annually in the first week of January.
- **Comprehensive Migration and Mobility Partnership Agreement (MMPA)** India signed the MMPA with Austria. Along similar lines, India has also signed agreements with other European countries namely, France, the United Kingdom, Germany and Finland. This agreement aims at the facilitation of mobility of students, academics, and

researchers, migration for professional and economic reasons, and abiding by equal treatment of nationals of both Parties in a similar situation.

- **National Genome Editing & Training Centre (NGETC)** : Union Minister inaugurates National Genome Editing & Training Centre at NABI Mohali, Punjab. NABI, under the Department of Biotechnology, is a national institute with a mandate focusing on research activities at the interface of Agriculture, Food and nutritional biotechnology. Genome editing is a method that lets scientists change the DNA of many organisms, including plants, bacteria, and animals. Editing DNA can lead to changes in physical traits, like eye colour, and disease risk. Scientists use different technologies to do this.
- **Global Risk Report** : Recently, the World Economic Forum (WEF) has released the 18th Edition of Global Risks Report 2023, which seeks that the world be prepared for 'natural disasters and extreme weather events' in the next two years. India has been ranked as the 4th most severe risk in the long term or over the next ten years (by 2033).
- **International Energy Forum** : India hosted 9th Asian Ministerial Energy Roundtable in association with International Energy Forum in Bengaluru. The theme was "Mapping new pathways for energy security, inclusive growth and energy transitions". IEF is world's largest international organization (including India), with Headquarters at Riyadh, Saudi Arabia includes both energy producing and consuming nations.
- **Red Sanders** : TRAFFIC factsheet highlights red sanders is India's most exploited tree species. The species is endemic to a distinct tract of forests in Andhra Pradesh. It falls in the category of Endangered Species in IUCN. Initiatives taken by India to protect the species- export prohibition under Foreign Trade Policy, Red Sanders Anti-Smuggling Task Force (RSASTF)-2015, Operation Rakth Chandan.
- **World Wetland Day** : The day is celebrated every year on 2nd February to create awareness about conservation, significance and the role of wetlands in the protection of biodiversity. Theme for 2023 is "It's Time for Wetlands Restoration". With 75 Ramsar sites covering over 13 lakh Hectares, India has the largest number of Wetlands **World Wetlands Day, 2023** in South Asia.

Test Yourself!

1. Which of the following gives 'Global Gender Gap Index' ranking to the countries of the world?
 - (a) World Economic Forum
 - (b) UN Human Rights Council
 - (c) UN Women
 - (d) World Health Organization
2. With reference to the trans fats, identify the incorrect statement:
 - (a) They are obtained naturally as well as at industry level.
 - (b) WTO aimed to eliminate trans fats by 2023.
 - (c) These are unsaturated fats produced only through artificial ways
 - (d) None of these
3. Which country hosted 9th Asian Ministerial Energy Roundtable in association with International Energy Forum?
 - (a) Germany
 - (b) India
 - (c) Switzerland
 - (d) United kingdom
4. Consider the following statements regarding Wetlands.

Statement I : In India, Wetlands are regulated under the Environment (Protection) Rules, 1986.

Statement II : Wetlands International is a sub-branch of UN Environment, that works to sustain and restore wetlands and their resources for people and biodiversity

 - (a) Only statement I is correct.
 - (b) Only statement II is correct.
 - (c) Both statements are correct
 - (d) Both statements are incorrect
5. National Genome Editing & Training Centre, is a national institute with a mandate focusing on research activities at the interface of Agriculture, Food and nutritional biotechnology. In which city it is located?
 - (a) Ludhiana
 - (b) Delhi
 - (c) Mohali
 - (d) Bengaluru
6. Consider the following statements about Red Sanders:
 - I. It is a species found in the southern tropical dry deciduous forest of Andhra Pradesh (AP).
 - II. It has been listed as Vulnerable on the IUCN Red List.
 - (a) Only statement I is correct.
 - (b) Only statement II is correct.
 - (c) Both statements are correct
 - (d) Both statements are incorrect
7. Genome editing is constantly in news, select the correct statement about this:
 - (a) Genome editing is a group of technologies that give scientists the ability to change an organism's DNA.
 - (b) Genome editing is of great interest in the prevention and treatment of only communicable diseases.
 - (c) The basic difference between genome editing and genetic engineering is that while the former does involve the introduction of foreign genetic material, the latter does not.
 - (d) None of the above
8. With which of the following countries India signed Comprehensive Migration and Mobility Partnership Agreement (MMPA)?
 - (a) Germany, United States
 - (b) Austria, France, and the United Kingdom
 - (c) Switzerland, Turkey and Saudi Arabia
 - (d) Nepal, Bhutan and Sri Lanka
9. Select the incorrect statement about Birsa Munda:
 - (a) He showed that the tribal people had the capacity to protest against injustice and express their anger against colonial rule.
 - (b) The 'Santhal Uprising' as the movement came to be called, aimed at establishing Munda Raj by driving out the British.
 - (c) He belonged to the Munda tribe in the Chhotanagpur Plateau area.
 - (d) All of these
10. Where is the Headquarters of Indian Science Congress Association (ISCA) located?
 - (a) Kolkata
 - (b) Bengaluru
 - (c) Delhi
 - (d) Chennai

Answer Key

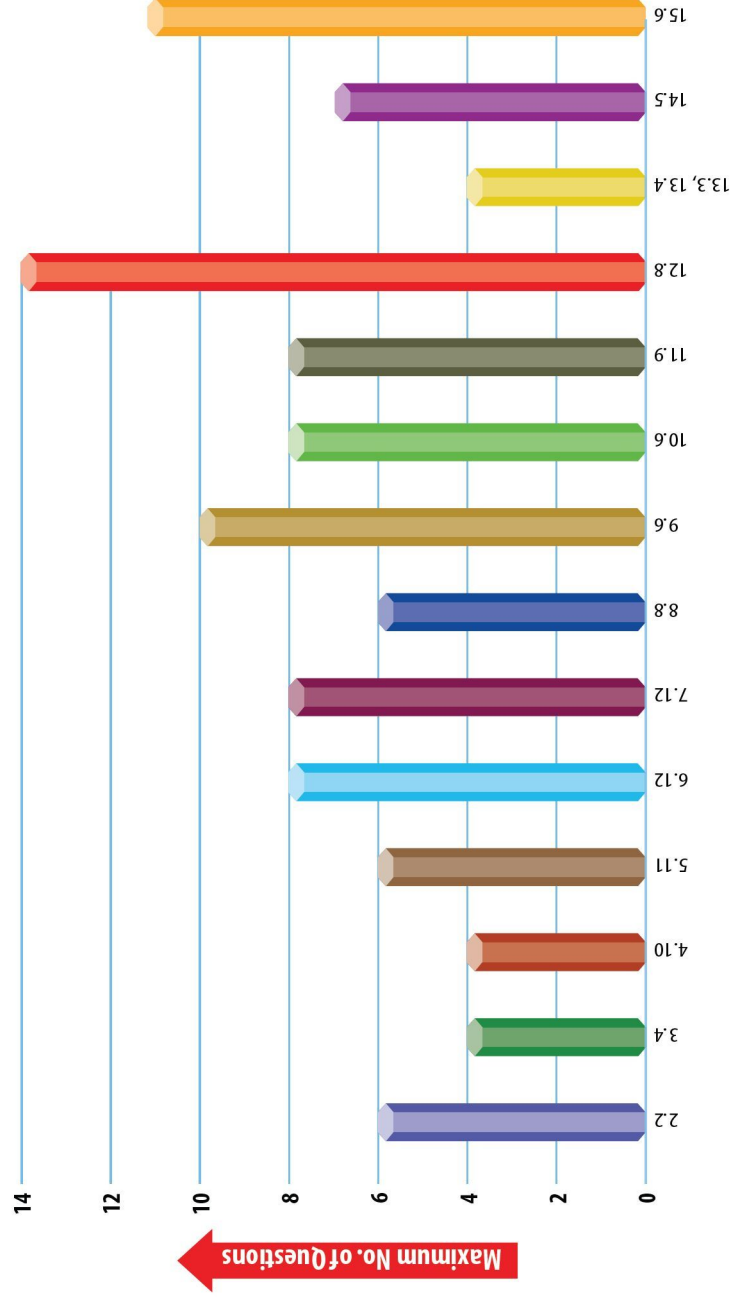
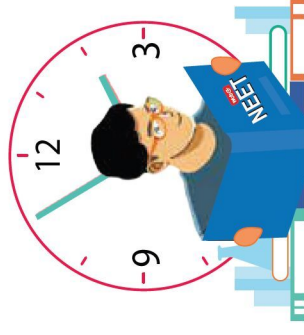
1. (a) 2. (c) 3. (b) 4. (d) 5. (c)
6. (a) 7. (a) 8. (b) 9. (b) 10. (a)



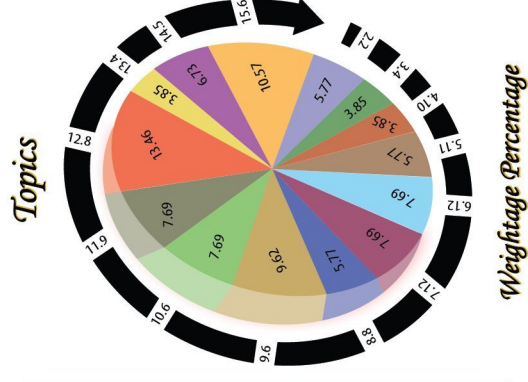
Are You Ready for **NEET**?

Past 10 Years (2013-2022) Chapterwise and Topicwise Trend Analysis of NEET Questions

CLASS **11**



Physics NCERT Topics*



*These are the topics from where maximum number of questions have been asked in the past 10 years.

02 | Units and Measurements

Accuracy, Precision of Instrument and Errors in Measurement

If n^{th} division of vernier scale coincides with $(n - 1)$ divisions of main scale.

$$n\text{VSD} = (n - 1)\text{MSD} \Rightarrow 1\text{VSD} = \frac{(n-1)}{n}\text{MSD}$$

$$\therefore \text{Least count} = 1\text{MSD} - 1\text{VSD}$$

$$= 1\text{MSD} - \frac{(n-1)}{n}\text{MSD} = \frac{1}{n}\text{MSD}$$

$$\text{LC} = \frac{\text{Value of one main scale division}}{\text{Total number of divisions on vernier scale}}$$

Accuracy of measurement is expressed either as relative error or fractional error or percentage error.

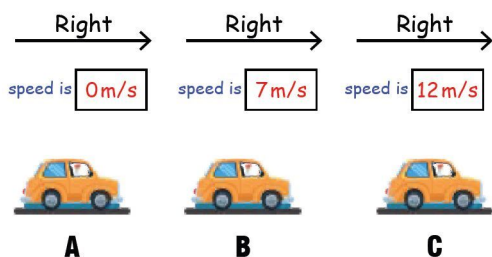


03 | Motion in a Straight Line

Instantaneous Speed

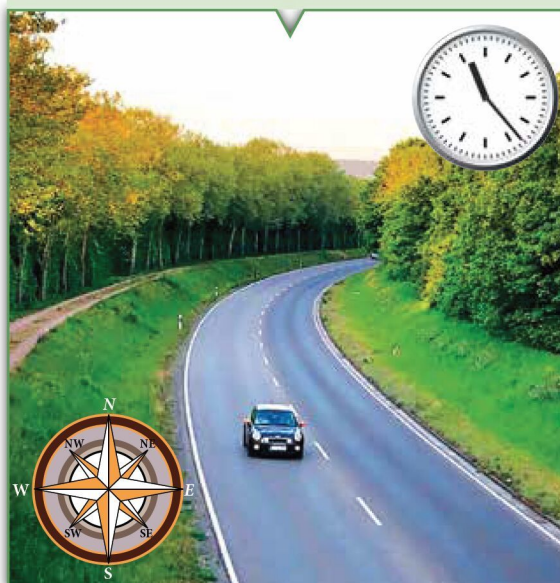
When the speed of an object is variable, then the object possesses different speeds at different instants. The speed of an object at a given instant of time or at a particular point on its path is

$$\text{Instantaneous speed, } v = \lim_{\Delta t \rightarrow 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$$



Speed of the car
at a particular instant

The instantaneous velocity includes the direction with that speed. For example, 8 m/s to the right was the instantaneous velocity of this person at that particular moment in time.

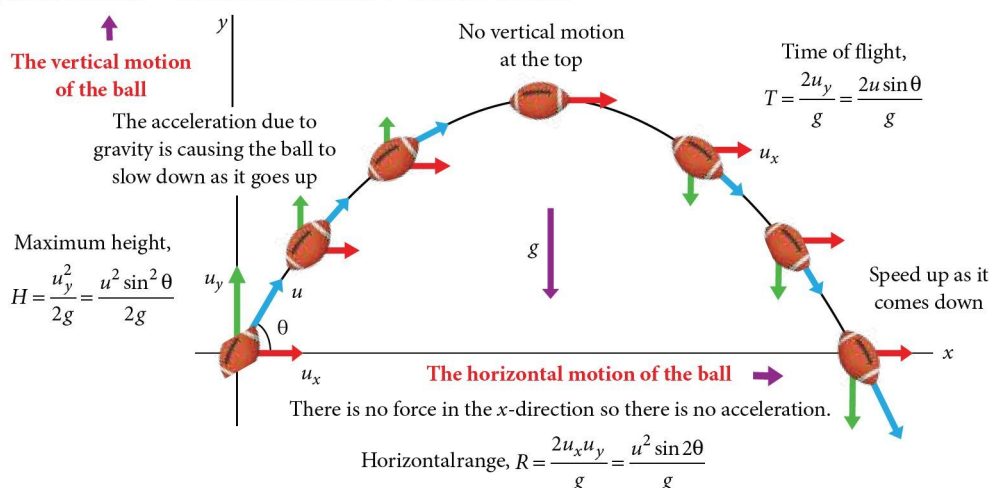




04 | Motion in a Plane

Projectile Motion

- A particle thrown in the space which moves under the effect of gravity only is called a projectile.
- Projectile motion is the combination of two motions.
- Projectile Motion = Horizontal Motion + Vertical Motion



05 | Laws of Motion

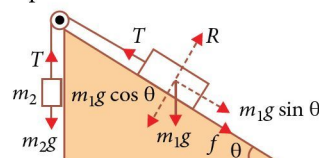
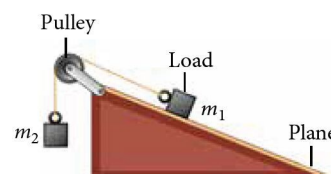
Solving Problems in Mechanics

Here a monkey of mass m climbs on a massless rope which can stand a maximum tension, $T_{\max}$. Tension in the rope will be equal to apparent weight of the monkey, R . The rope will break when R exceeds $T_{\max}$.



- When the monkey climbs up with an acceleration, a then, $R = m(g + a)$
If $R > T$, then the rope will break.
- When the monkey climbs down with same acceleration, a then, $R = m(g - a)$
If $R < T$, then the rope will not break.
- If the monkey climbs with uniform speed and zero acceleration, $a = 0$. $\therefore R = mg$
- When the monkey falls down the rope freely under gravity $a = g$, $\therefore R = m(g - a) = \text{zero}$
Rope will not break.

Here, two blocks of masses m_1 and m_2 are connected by a string of neglected mass, which passes over a frictionless pulley fixed on the top of an inclined plane as shown in figure. When the angle of inclination is θ , the mass m_1 just begins to move up the inclined plane.



The block m_1 would just begin to move up, when tension in the string is

$$T = m_2 g = m_1 g \sin \theta + f = m_1 g \sin \theta + \mu R$$

$$m_2 g = m_1 g \sin \theta + \mu m_1 g \cos \theta$$

Two block of masses M and m are connected by a weightless string passing over a frictionless pulley as shown in the figure.

Let T be the tension in the string and a be the acceleration of the system. Their equation of motion are

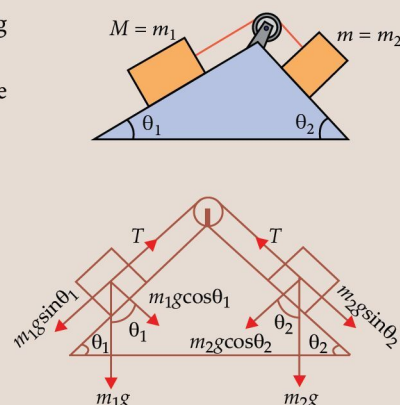
$$Mg\sin\theta_1 - T = Ma;$$

$$T - mg\sin\theta_2 = ma$$

We have, $\theta_1 = \theta_2 = \theta$, then $(M + m)a = (M - m)g \sin\theta$

$$a = \frac{(M - m)g \sin\theta}{(M + m)}. \text{ Also, } T = mg\sin\theta + ma$$

$$T = \frac{2mMg \sin\theta}{M + m}$$



06 | Work, Energy and Power

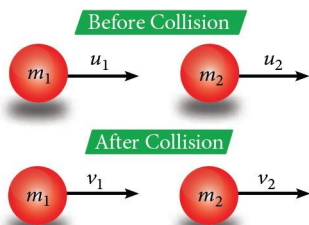
Collisions

Here Two Balls Collide Elastically

- Velocities of the balls after the collision

$$v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2} \right) u_1 + \frac{2m_2}{m_1 + m_2} u_2$$

$$\text{and } v_2 = \left(\frac{m_2 - m_1}{m_1 + m_2} \right) u_2 + \frac{2m_1}{m_1 + m_2} u_1$$

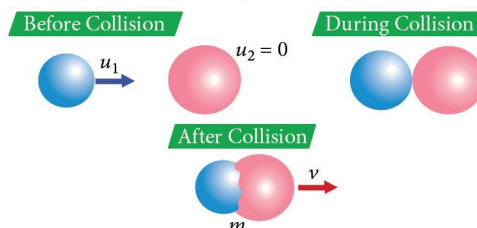


Here Two Balls Collide Inelastically

- Velocities of the balls after the collision

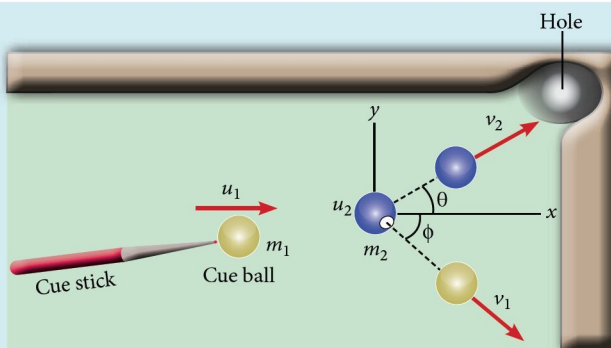
$$v_1 = \left(\frac{m_1 - em_2}{m_1 + m_2} \right) u_1 + \left(\frac{(1+e)m_2}{m_1 + m_2} \right) u_2;$$

$$v_2 = \left(\frac{(1+e)m_1}{m_1 + m_2} \right) u_1 + \left(\frac{m_2 - em_1}{m_1 + m_2} \right) u_2$$



Two dimensional collision : During two dimensional collision (as shown in the figure) we can separately conserve momentum along x and y -axis.

Here in cue sport, the cue ball having mass m_1 , when hit by the ace stick, is moving with velocity u_1 , hits another cue ball at rest having mass m_2 . After collision, both cue balls move with velocities v_1 and v_2 making angle ϕ and θ respectively, with the x -axis.





07 | System of Particles and Rotational Motion

Dynamics of Rotational Motion about a Fixed Axis

In a circular motion, the object just moves in a circle whereas in rotational motion the object rotates about an axis.

A ferris wheel is a structure consisting of a rotating upright wheel with multiple passenger-carrying cabins. The wheel itself follows a rotational motion. These passenger-cabins are attached to the rim in such a way that all the cabins move in a circle. So, the motion of people riding the ferris wheel while sitting inside the cabin, can be considered as circular motion. Hence, the motion of a ferris wheel is rotational in motion.

Here, consider only these forces that lie in planes perpendicular to the axis. Forces which are parallel to the axis will give torques perpendicular to the axis. Work done by a force acting on a particle of a body rotating about a fixed axis, $dW_{\perp} = \tau d\theta$, where $d\theta$ is a angular displacement.



08 | Gravitation

Escape Speed

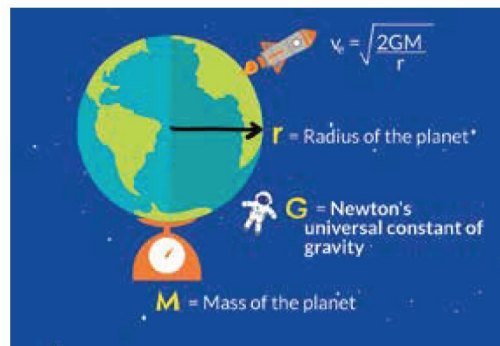
The escape speed on the Earth is the minimum speed with which a body has to be projected vertically upwards from the surface of Earth so that it just crosses the gravitational field of Earth and never returns on its own.

$$v_e = \sqrt{\frac{2GM}{R}}$$



If speed of projection (v) of the body from the surface of a planet is greater than the escape speed of that planet, the body will escape out from the gravitational field of that planet and will move in the interstellar space with speed,

$$\sqrt{v^2 - v_e^2}$$

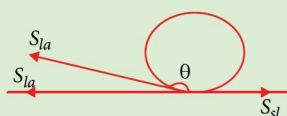


10 | Mechanical Properties of Fluids

Surface Tension

It is the property due to which the free surface of liquid tends to have minimum surface area and behaves like a stretched membrane. When the free surface of a liquid comes in contact with a solid, it becomes curved at the near the point of contact.

Shape of water drops with interfacial tensions as shown in figure on a lotus leaf.

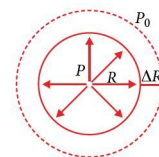


A soap bubble has two surfaces which are in contact with air both inside and outside the bubble. The molecules, lying on the surface of liquid bubble will experience a resultant force acting inwards perpendicular to the surface due to surface tension. Since, the size of soap bubble



cannot be reduced to zero, therefore the pressure inside the soap bubble must be greater than the pressure outside it. This excess of pressure inside the bubble will provide a force acting outwards perpendicular to the surface of bubble to counter balance the resultant force due to surface tension and the bubble is in equilibrium.

Work done by the excess pressure (P), $W = p \times 4\pi R^2 \times \Delta R$.

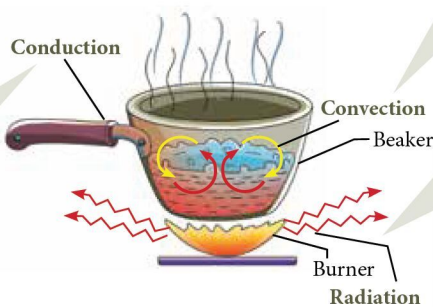


11 | Thermal Properties of Matter

Heat Transfer

Three modes of heat transfer are as indicated in the diagram.

Here, heat is being transferred from one point (beaker) to other point (handle) of a substance in the direction of fall of temperature, without any actual motion of particles of the substance.



Heat transfer during boiling

Heat is transmitted from one point to another due to actual motion of heated particles (here fluid particles) in liquids and gases.

The process of heat transfer from one point (burner) to another point (surroundings) without heating the intervening medium is called radiation.



12 | Thermodynamics

Thermodynamics Process

Isobaric Process

Thermodynamics process in which the pressure remains constant.



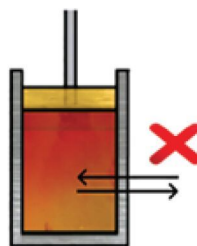
Isochoric Process

Thermodynamics process in which the volume remains constant.



Adiabatic Process

Thermodynamics process in which there is no heat transfer involved.



Isothermal Process

The process in which the temperature remains constant.



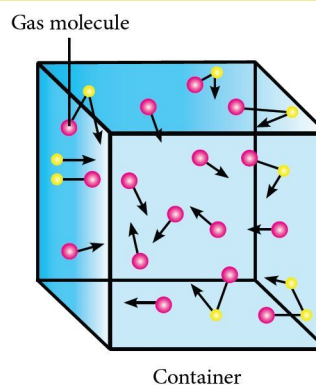
Cyclic process consists of a series of changes which return the system back to its initial state. In non-cyclic process, the series of changes involved do not return the system back to its initial state.



13 | Kinetic Theory

Kinetic Theory of an Ideal Gas

- Gas particles have random motions. Each time a particle collides with the walls of its container, there is a force exerted on the wall and hence on the gas particles.
- **Basic assumptions of kinetic theory**
 - Intermolecular distances are very large as compared to the size of molecules.
 - Collision between the molecules and the walls of container is perfectly elastic.
 - The energy possessed by molecules is purely kinetic energy.
 - The density remains uniform throughout the gas.



14 | Oscillations

Velocity and Acceleration in Simple Harmonic Motion

Here, a block of mass m is attached to a spring having spring constant k is free to oscillate with angular velocity ω , as shown in figure.

- At any instant, the rate of change of displacement with respect to time of particle executing SHM is known as its velocity

$$\text{i.e., } v(t) = \frac{dx(t)}{dt} = \frac{d}{dt}[A \cos(\omega t + \phi)] \Rightarrow v(t) = -\omega A \sin(\omega t + \phi)$$

where, $v(t)$ is the velocity of the projection of reference particle in S.H.M.

$$\Rightarrow v(t) = -\omega A \sqrt{1 - \cos^2(\omega t + \phi)} \Rightarrow v(t) = -\omega \sqrt{A^2 - x^2}$$

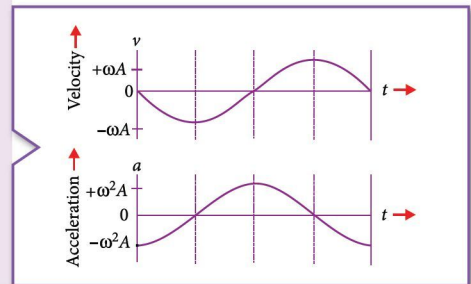
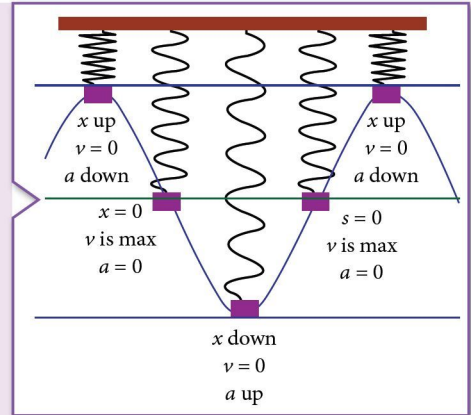
- For $x = 0$, i.e., at mean position, velocity is maximum.
 $v(t) = -\omega A = -v_m$ (velocity amplitude)
- For $x = A$, i.e., at extreme position, velocity is minimum,
 $v(t) = 0$.
- At any instant, the rate of change of velocity with respect to time of a particle executing simple harmonic motion is known as its acceleration i.e.,

$$a(t) = \frac{d}{dt}v(t) = \frac{d}{dt}(-\omega A \sin(\omega t + \phi))$$

$$a(t) = -\omega^2 A \cos(\omega t + \phi) \Rightarrow a(t) = -\omega^2 x(t)$$

- For $x = 0$, i.e., at mean position, $a(t) = 0$
- For $x = A$, i.e., at extreme position, $a(t) = -\omega^2 A$

Here, graphs show velocity and acceleration of a block in SHM.



15 | Waves

Reflection of Waves

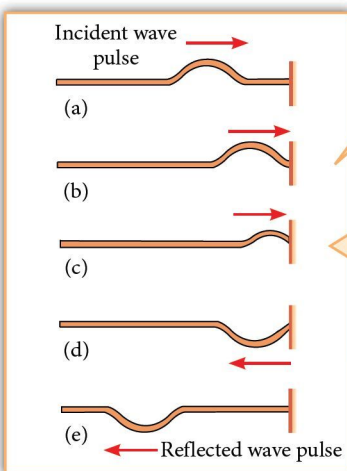
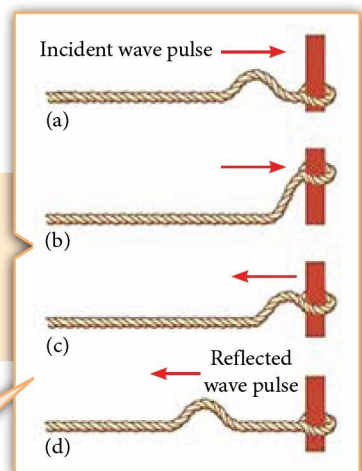


Figure shows, the reflection of a travelling wave pulse at the fixed end of stretched string. The reflected pulse is inverted, but its shape is otherwise unchanged.

What happens when a wave travelling in one medium reaches a boundary where two media are separated. The wave gets partly reflected back in the same medium and partly refracted (transmitted) to the other medium.

Figure shows, the reflection of a travelling pulse at the free end of stretched string. The reflected pulse is not inverted.

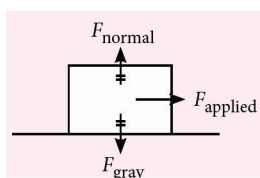




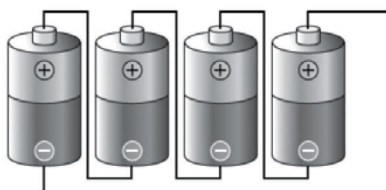
Unlock Your Knowledge!



1. What is the net charge on a capacitor?
2. Name the rays which are used in the lasik eye surgery.
3. What is the colour of sky as seen from the moon surface?
4. Name a device used to regulate the voltage or used as a d.c. voltage regulator.
5. Name the friction force which is self adjusting in nature.
6. Name the sound waves produced by the bats.
7. Why on hitting the carpet with stick, dust flies away?
8. Light year is a unit of_____.
9. What is the time period of the pendulum of a scientific clock?
10. Which unit is used to measure the speed of a ship?
11. In the given diagram, several forces act on a body. The type of motion of block is_____.

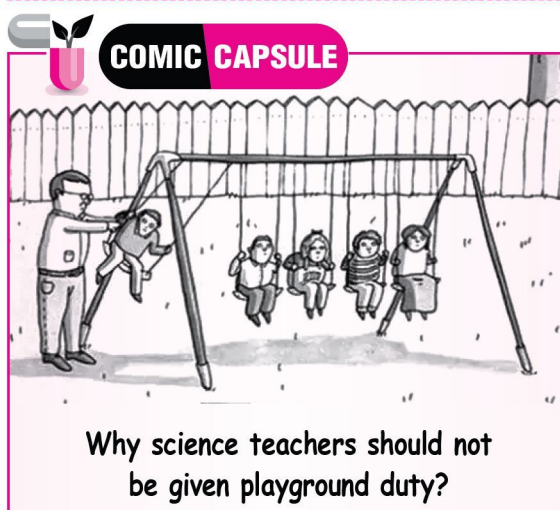


12. An electrician construct a circuit using four 1.5 V batteries. What will be the voltage provided by this set up?



13. What is the source of energy of the sun?
14. Name the phenomenon of light in which it is being deflected when travelling obliquely from one medium to another?
15. Name a device used to measure the depth of sea.
16. When a force is applied on a body and then, there is displacement in the position of body due to this force. Can work done by the force is zero?
17. When the red light is exposed on a green leaf. What is the colour of leaf appear?
18. What is the nature of lens used in simple microscope?
19. Which substance is a good conductor of heat but bad conductor of electricity?
20. What is the frequency of direct current? ◆◆

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month. Winners' names and answers will be published in next issue.





Exam on 30th April 2023

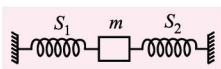
WB JEE

PRACTICE PAPER 2023

Category-I (Q.1 to 30)

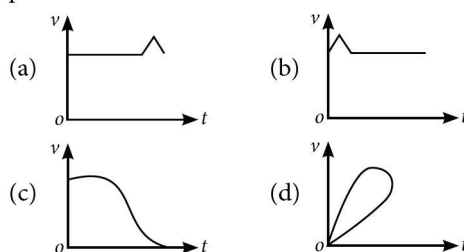
(Carry 1 mark each. Only one option is correct. Negative marks $-\frac{1}{4}$)

- A stone of mass m tied to a string of length l rotates along circumference of a circle with constant speed v . The torque on the stone is
(a) zero (b) $mv^2 \times l$
(c) $\frac{m^2 v}{l}$ (d) $\frac{mv^2}{l}$
- A charged particle of mass 10^{-3} kg and charge 10^{-5} C enters a magnetic field of induction 1 T. If $g = 10 \text{ m s}^{-2}$, for what value of velocity will it pass straight through the field without deflection?
(a) 10^{-3} m s^{-1} (b) 10^3 m s^{-1}
(c) 10^6 m s^{-1} (d) 1 m s^{-1}
- A Carnot engine takes 3×10^6 cal of heat from a reservoir at 627°C and gives it to a sink at 27°C . The work done by the engine is
(a) $4.2 \times 10^6 \text{ J}$ (b) $8.4 \times 10^6 \text{ J}$
(c) $16.8 \times 10^6 \text{ J}$ (d) zero.
- What is the value of inductance L for which the current is maximum in a series LCR circuit with $C = 10 \mu\text{F}$ and $\omega = 1000 \text{ s}^{-1}$?
(a) 1 mH
(b) cannot be calculated unless R is known
(c) 10 mH
(d) 100 mH.
- In the figure S_1 and S_2 are identical springs. The oscillation frequency of the mass m is f . If one spring is removed, the frequency will become
(a) f (b) $f/\sqrt{2}$
(c) $f \times 2$ (d) $f \times \sqrt{2}$.
- The electric and magnetic field of an electromagnetic wave are



- (a) in opposite phase and perpendicular to each other
(b) in opposite phase and parallel to each other
(c) in phase and perpendicular to each other
(d) in phase and parallel to each other.

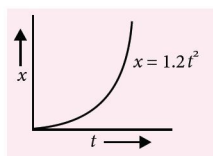
- Which of the following velocity-time graph is not possible?



- A $4 \mu\text{F}$ capacitor is charged to 400 V. If its plates are joined through a resistance of $2 \text{ k}\Omega$, then heat produced in the resistance is
(a) 0.64 J (b) 1.28 J (c) 0.16 J (d) 0.32 J.
- A steel ring of radius r and cross-sectional area A is fitted onto a wooden disc of radius R ($R > r$). If Young's modulus be Y , then the force with which the steel ring is expanded, is
(a) $AY \frac{R}{r}$ (b) $AY \left[\frac{R-r}{r} \right]$
(c) $\frac{Y}{A} \left[\frac{R-r}{r} \right]$ (d) $\frac{Yr}{AR}$
- A plano-convex lens fits exactly into a plano-concave lens. Their plane surfaces are parallel to each other. If the lenses are made of different material of refractive indices μ_1 and μ_2 and R is the radius of curvature of the curved surface of the lenses, then focal length of the combination is
(a) $\frac{R}{\mu_1 - \mu_2}$ (b) $\frac{2R}{\mu_2 - \mu_1}$

(c) $\frac{R}{2(\mu_1 - \mu_2)}$ (d) $\frac{R}{2 - (\mu_1 + \mu_2)}$

11. Given figure shows the distance-time graph of the motion of a car. It follows from the graph that the car is



- (a) at rest.
(b) in uniform motion.
(c) in non-uniform acceleration.
(d) uniformly accelerated.
12. A cylinder of radius R and length L is placed in a uniform electric field E parallel to the cylinder axis. The total flux for the surface of the cylinder is given by

(a) $2\pi R^2 E$ (b) $\pi R^2/E$
(c) $\frac{\pi R^2 + \pi R^2}{E}$ (d) zero

13. If 3.8×10^{-6} is added to 4.2×10^{-5} giving due regard to significant figures, then the result will be
(a) 4.58×10^{-5} (b) 4.6×10^{-5}
(c) 4.5×10^{-5} (d) none of these.

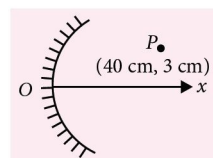
14. Consider a solid sphere of radius r and mass m which has a charge q distributed uniformly over its volume. The sphere is rotated about a diameter with an angular speed ω . The magnetic moment of the sphere is

(a) $\frac{1}{3}q\omega r^2$ (b) $\frac{1}{5}q\omega r^2$ (c) $\frac{1}{7}q\omega r^2$ (d) $\frac{1}{9}q\omega r^2$

15. A ball is dropped from a spacecraft revolving around the earth at a height of 120 km. What will happen to the ball?

- (a) it will fall down to the earth gradually
(b) it will go very far in the space
(c) it will continue to move with the same speed along the original orbit of spacecraft
(d) it will move with the same speed, tangentially to the spacecraft.

16. The coordinates of the image of point object P formed by a concave mirror of radius of curvature 20 cm (consider paraxial rays only) as shown in the figure is



- (a) (13.33 cm, -1 cm) (b) (13.33 cm, +1 cm)
(c) (-13.33 cm, +1 cm) (d) (-13.33 cm, -1 cm)

17. A fan produces a feeling of comfort during hot weather because

- (a) a fan supplies cool air
(b) our perspiration evaporates rapidly
(c) fan cools the air
(d) conductivity of air increases.

18. The work done in carrying a charge Q once around a circle of radius r about a charge q at the centre is

(a) $\frac{qQ}{4\pi\epsilon_0 r}$ (b) $\frac{qQ}{4\pi\epsilon_0} \frac{1}{\pi r}$
(c) $\frac{qQ}{4\pi\epsilon_0} \left(\frac{1}{2\pi r} \right)$ (d) 0

19. An object weighs m_1 in a liquid of density d_1 and that in liquid of density d_2 is m_2 . The density d of the object is

(a) $d = \frac{m_2 d_2 - m_1 d_1}{m_2 - m_1}$ (b) $d = \frac{m_1 d_1 - m_2 d_2}{m_2 - m_1}$
(c) $d = \frac{m_2 d_1 - m_1 d_2}{m_1 - m_2}$ (d) $d = \frac{m_1 d_2 - m_2 d_1}{m_1 - m_2}$

20. The light beams of intensities in the ratio of 9 : 1 are allowed to interfere. What will be the ratio of the intensities of maxima and minima?

(a) 3 : 1 (b) 4 : 1 (c) 25 : 9 (d) 81 : 1

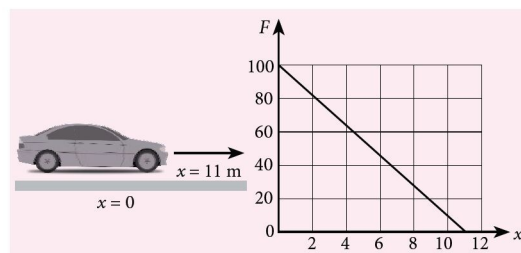
21. A man is walking on a road with a velocity 3 km/h. Suddenly rain starts falling. The velocity of rain is 10 km/h in vertically downward direction. The relative velocity of rain is

(a) $\sqrt{13}$ km/h (b) $\sqrt{109}$ km/h
(c) $\sqrt{7}$ km/h (d) 13 km/h

22. A and B are isotopes. B and C are isobars. If d_A , d_B and d_C be the densities of nuclei A, B and C respectively then

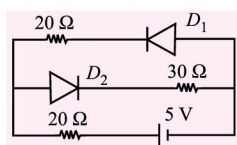
(a) $d_A > d_B > d_C$ (b) $d_A < d_B < d_C$
(c) $d_A = d_B = d_C$ (d) $d_A = d_B < d_C$

23. A toy car of mass 5 kg moves up a ramp under the influence of force F plotted against displacement x . The maximum height attained is given by (Given : $g = 10 \text{ m/s}^2$)



- (a) 20 m (b) 15 m (c) 11 m (d) 5 m

24. The current in the circuit will be



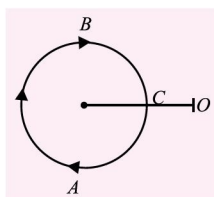
- (a) 5/40 A (b) 5/50 A
(c) 5/10 A (d) 5/20 A
25. If Wien's constant, $b = 0.3 \text{ cm-K}$, then the temperature of the Sun having maximum intensity of radiation at 5000 Å wavelength is
- (a) 3000 K (b) 4000 K
(c) 5000 K (d) 6000 K

26. A junction diode has a resistance of 25Ω when forward biased and 2500Ω when reverse biased. The current in the diode, for the arrangement shown will be



- (a) $\frac{1}{15} \text{ A}$ (b) $\frac{1}{7} \text{ A}$ (c) $\frac{1}{25} \text{ A}$ (d) $\frac{1}{480} \text{ A}$

27. A small source of sound moves on a circle as shown in the figure and an observer is sitting on O. Let n_1, n_2 and n_3 be the frequencies heard when the source is at A, B and C respectively, then



- (a) $n_1 > n_2 > n_3$ (b) $n_2 > n_3 > n_1$
(c) $n_1 = n_2 > n_3$ (d) $n_2 > n_1 > n_3$
28. If a hydrogen atom emits a photon of energy 12.1 eV , its orbital angular momentum changes by ΔL . Then, ΔL equals
- (a) $1.05 \times 10^{-34} \text{ J s}$ (b) $2.11 \times 10^{-34} \text{ J s}$
(c) $3.16 \times 10^{-34} \text{ J s}$ (d) $4.22 \times 10^{-34} \text{ J s}$

29. Two stationary sources each emitting waves of wavelength λ , an observer moves from one source to another with velocity u . Then number of beats heard by him is

- (a) $\frac{2u}{\lambda}$ (b) $\frac{u}{\lambda}$ (c) $\sqrt{u\lambda}$ (d) $\frac{u}{2\lambda}$

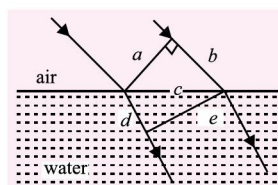
30. A magnetic field of $2 \times 10^{-2} \text{ T}$ acts at right angles to a coil of area 100 cm^2 , with 50 turns. The average e.m.f. induced in the coil is 0.1 V , when it is removed from the field in t sec. The value of t is
- (a) 10 s (b) 0.1 s (c) 0.01 s (d) 1 s

Category-II (Q.31 to 35)

(Carry 2 marks each. Only one option is correct. Negative marks $-\frac{1}{2}$)

31. A body is projected from the ground with a velocity $\vec{v} = (3\hat{i} + 10\hat{j}) \text{ m s}^{-1}$. The maximum height attained and the range of the body respectively are (given $g = 10 \text{ m s}^{-2}$)
- (a) 5 m and 6 m (b) 3 m and 10 m
(c) 6 m and 5 m (d) 3 m and 5 m

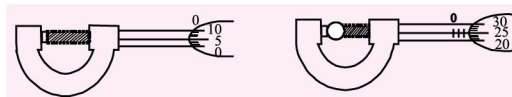
32. Figure shows plane waves refracted from air to water. Using Huygen's principle, find the ratio of refractive index of water w.r.t. air from the diagram, if a, b, c, d, e are lengths on the diagram.



- (a) a/e (b) b/e (c) b/d (d) d/b
33. When the intensity of a light source is increased
- (a) the number of photons emitted by the source in unit time increases
(b) the total energy of the photons emitted per unit time decreases
(c) more energetic photons are emitted
(d) none of these.
34. Assuming the sun to have a spherical outer surface of radius r , radiating like a black body at temperature $t^\circ\text{C}$, the power received by a unit surface, (normal to the incident rays) at a distance R from the centre of the Sun is where σ is the Stefan's constant.

- (a) $\frac{r^2 \sigma (t + 273)^4}{4\pi R^2}$ (b) $\frac{16\pi^2 r^2 \sigma t^4}{R^2}$
(c) $\frac{r^2 \sigma (t + 273)^4}{R^2}$ (d) $\frac{4\pi r^2 \sigma t^4}{R^2}$

35. The circular divisions of the given screw gauge are 50. It moves 0.5 mm on main scale in one rotation. The diameter of the ball is

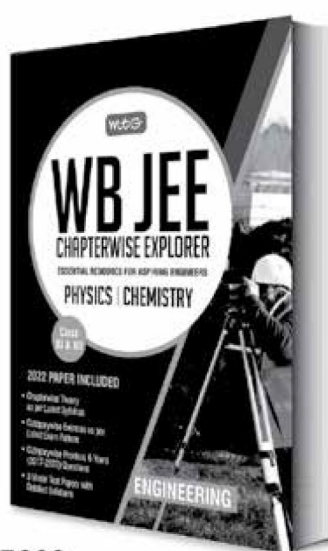


- (a) 2.25 mm (b) 2.20 mm
(c) 1.20 mm (d) 1.25 mm.

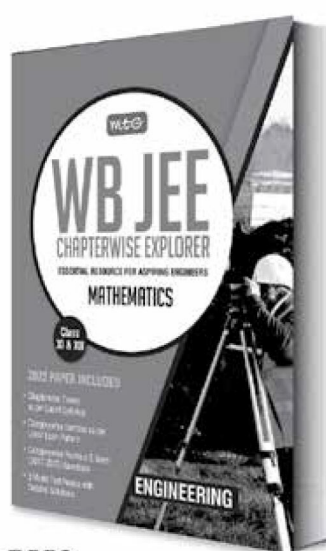


CHAPTERWISE EXPLORER

WB JEE



₹ 800



₹ 550

Highlights

- Chapterwise Theory as per Latest Syllabus
- Categorywise Exercise as per Latest Exam Pattern
- Categorywise Previous 6 Years (2017-2022) Questions
- 3 Model Test Papers with Detailed Solutions

Success in JEE 2023 Now Made Easy !

Visit
www.mtg.in
for latest offers
and to buy
online!



MTG Learning Media (P) Ltd.
Plot # 99, Sector 44, Gurugram - 122 003 (HR)

Available at all leading book shops throughout India.
For more information or for help in placing your order,
Call 0124-6601200 or e-mail: info@mtg.in

Category - III (Q.36 to 40)

(Carry 2 marks each. One or more options are correct. No negative marks)

36. A charged particle of unit mass and unit charge moves with velocity $\vec{v} = (8\hat{i} + 6\hat{j}) \text{ m s}^{-1}$ in magnetic field of $\vec{B} = 2\hat{k} \text{ T}$. Choose the correct alternative.

- (a) The path of the particle may be $x^2 + y^2 - 4x - 21 = 0$
 (b) The path of the particle may be $x^2 + y^2 = 25$
 (c) The path of the particle may be $y^2 + z^2 = 25$
 (d) The time period of the particle will be 3.14 s.

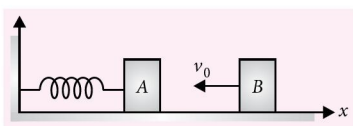
37. A non-conducting solid sphere of radius R is uniformly charged. The magnitude of the electric field due of the sphere at a distance r from its centre

- (a) increases as r increases, for $r < R$
 (b) decreases as r increases, for $0 < r < \infty$
 (c) decreases as r increases, for $R < r < \infty$
 (d) is discontinuous at $r = R$.

38. Which of the following statements are correct?

- (a) A ray of light is incident on a plane mirror and gets reflected. If the mirror is rotated through an angle θ , then the reflected ray gets deviated through angle 2θ .
 (b) A ray of light gets reflected successively from two mirrors which are mutually inclined. Angular deviation suffered by the ray does not depend upon angle of incidence on first mirror.
 (c) A plane mirror cannot form real image of a virtual object.
 (d) If an object approaches toward a plane mirror with velocity v , then the image approaches the object with velocity $2v$.

39. A block A of mass m connected with a spring of force constant k is executing SHM. The displacement time equation of the block is $x = x_0 + a \sin \omega t$. An identical block B moving towards negative x -axis with velocity v_0 collides elastically with block A at time $t = 0$. Then,



- (a) displacement time equation of A after collision

will be $x = x_0 - v_0 \sqrt{\frac{m}{k}} \sin \omega t$.

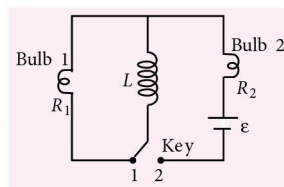
- (b) displacement time equation of A after collision

will be $x = x_0 + v_0 \sqrt{\frac{m}{k}} \sin \omega t$.

- (c) velocity of B just after collision will be $a\omega$ towards positive x -direction.

- (d) velocity of B just after collision will be v_0 towards positive x -direction.

40. Key is the position 2 for time t . Thereafter, it is in position 1. Resistance of the bulb and inductance of inductor are marked in the figure choose the correct alternative.



- (a) Bulb 2 dies as soon as key is switched into position 1.
 (b) Time in which brightness of bulb 1 become half its maximum brightness does not depend on t .
 (c) If $t = \infty$, total heat produced in bulb 1 is $\frac{L\varepsilon^2}{2R_2^2}$
 (d) Ratio of maximum power consumption of bulbs depends on time

SOLUTIONS

1. (a) : Torque $= r F \sin \phi = r F \sin 0^\circ = \text{zero}$

2. (b) : Since the charged particle passes straight without deflection, therefore weight force is balanced by the magnetic force, $Bqv = mg$

or $v = \frac{mg}{Bq} = \frac{10^{-3} \times 10}{1 \times 10^{-5}} = 10^3 \text{ m s}^{-1}$.

3. (b) : $T_1 = 627 + 273 = 900 \text{ K}$

$Q_1 = 3 \times 10^6 \text{ cal}$, $T_2 = 27 + 273 = 300 \text{ K}$

$\therefore \frac{Q_1}{T_1} = \frac{Q_2}{T_2} \Rightarrow Q_2 = \frac{T_2}{T_1} \times Q_1 = \frac{300}{900} \times 3 \times 10^6$
 $= 1 \times 10^6 \text{ cal}$

Work done $= Q_1 - Q_2 = 3 \times 10^6 - 1 \times 10^6$
 $= 2 \times 10^6 \text{ cal} = 2 \times 4.2 \times 10^6 \text{ J} = 8.4 \times 10^6 \text{ J}$

4. (d) : In series LCR, current is maximum at resonance.

$\therefore$ Resonant frequency $\omega = \frac{1}{\sqrt{LC}}$

$\therefore \omega^2 = \frac{1}{LC}$ or, $L = \frac{1}{\omega^2 C}$

Given $\omega = 1000 \text{ s}^{-1}$ and $C = 10 \mu\text{F}$

$\therefore L = \frac{1}{1000 \times 1000 \times 10 \times 10^{-6}} = 0.1 \text{ H} = 100 \text{ mH}$.

5. (b) : In case of spring, frequency = $\frac{1}{2\pi} \sqrt{\frac{K}{m}}$

As per question, the two springs are in parallel in horizontal position, effective force constant = $2K$,

$$f = \frac{1}{2\pi} \sqrt{\frac{2K}{m}}; f' = \frac{1}{2\pi} \sqrt{\frac{K}{m}}$$

when one spring is removed, $f' = \frac{f}{\sqrt{2}}$.

6. (c) : In electromagnetic wave, electric and magnetic field are in phase and perpendicular to each other and also perpendicular to the direction of the propagation of the wave.

7. (d) : The velocity-time graph in option (d) is not possible, because at a particular instant t , velocity cannot have two values.

8. (d) : Capacitance (C) = $4 \mu\text{F} = 4 \times 10^{-6} \text{ F}$; Voltage (V) = 400 volts and resistance (R) = $2 \text{ k}\Omega = 2 \times 10^3 \Omega$.

$$\text{Heat produced} = \text{Electrical energy stored} = \frac{1}{2} CV^2 \\ = \frac{1}{2} \times (4 \times 10^{-6}) \times (400)^2 = 0.32 \text{ J}$$

9. (b) : Strain = $\frac{\Delta l}{l} = \frac{2\pi R - 2\pi r}{2\pi r} = \left(\frac{R-r}{r}\right)$

$$\text{Stress} = Y \times \text{strain} \Rightarrow \frac{F}{A} = Y \times \text{strain}$$

$$\therefore F = Y \times A \times \text{strain} = YA \times \left(\frac{R-r}{r}\right)$$

10. (a) : $\frac{1}{F} = (\mu_1 - 1) \left(\frac{1}{\infty} + \frac{1}{R}\right) + (\mu_2 - 1) \left(\frac{1}{-R} - \frac{1}{\infty}\right)$

$$\frac{1}{F} = \left(\frac{\mu_1 - 1}{R}\right) - \left(\frac{\mu_2 - 1}{R}\right)$$

$$\therefore \frac{1}{F} = \frac{\mu_1 - \mu_2}{R} \quad \text{or} \quad F = \frac{R}{\mu_1 - \mu_2}$$

11. (d) : Since $x = 1.2t^2$ which is in form $x = \frac{1}{2}at^2$. Thus the motion is uniformly accelerated.

12. (d) : $\phi_A = E \cdot ds$

$$\phi_B = -E \cdot ds; \phi_C = \int E ds \cos 90^\circ = 0.$$

$$\text{Total flux } \phi_A + \phi_B + \phi_C = E \cdot ds - E \cdot ds + 0 \\ = E\pi R^2 - E\pi R^2 + 0 = 0.$$

13. (b) : $3.8 \times 10^{-6} + 4.2 \times 10^{-5} = 3.8 \times 10^{-6} + 42 \times 10^{-6} \\ = 45.8 \times 10^{-6} = 4.58 \times 10^{-5} = 4.6 \times 10^{-5}$
(Round off to first decimal place)

14. (b) : Ratio of magnetic moment and angular momentum is given by $\frac{M}{L} = \frac{q}{2m}$

$$\therefore \frac{M}{\frac{2}{5}mr^2\omega} = \frac{q}{2m} \quad \text{or} \quad M = \frac{1}{5}q\omega r^2 \quad \left[\because \begin{aligned} L &= I\omega \\ I &= \frac{2}{5}mr^2 \end{aligned} \right]$$

15. (c) : Since no external torque is applied therefore, according to law of conservation of angular momentum, the ball will continue to move with the same angular velocity along the original orbit of the spacecraft.

16. (d) : $\frac{1}{v} - \frac{1}{40} = \frac{1}{-10}; \frac{1}{v} = \frac{-1}{10} + \frac{1}{40}$

Physics bulletin

Ghostly neutrinos provide new path to study protons

Neutrinos are one of the most abundant particles in our universe, but they are notoriously difficult to detect and study; they don't have an electrical charge and have nearly no mass. They are often referred as 'Ghost Particles' because they rarely interact with atoms.

But because they are so abundant, they play a large role in helping scientists answer fundamental questions about the universe.

Like a number of previous scientific discoveries, this also came almost accidentally, as the researchers were studying neutrinos in the Fermi National Accelerator Laboratory, also called Fermilab, while a part of the MINERvA international collaborative effort.

Tejin Cai, the paper's first Author says, "While we were studying neutrinos as part of the MINERvA experiment, I realised a technique I was using might be applied to investigate protons".

"We were not sure at first if it would work, but we ultimately discovered we could use neutrinos to measure the size and shape of the protons that make up the nuclei of atoms. It's like using a ghost ruler to make a measurement."

Researchers first measured the size of protons in the 1950s, using an accelerator with beams of electrons at Stanford University's linear accelerator facility. But instead of using beams of accelerated electrons, the new technique developed by Cai, McFarland, and their colleagues, uses beams of neutrinos specifically antineutrinos. Researchers are hoping to use the technique to separate the effects related to neutrino-scattering on protons from the effects related to neutrino-scattering on atomic nuclei, which are bound collections of protons and neutrons.

Cai further adds, "Our previous methods for predicting neutrino-scattering from protons all used theoretical calculations, but this result directly measures that scattering."

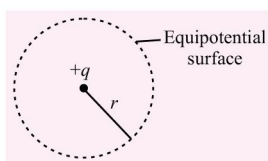
Along with this new study gathering more data about neutrinos, it also opens the door for predicting neutrino interactions for future experiments, as well.

$$\frac{1}{v} = \frac{-4+1}{40} = \frac{-3}{40}, v = \frac{-40}{3} = -13.33 \text{ cm}$$

$$\frac{h_i}{h_0} = \frac{-v}{u}, \frac{h_i}{3} = \frac{-\left(\frac{-40}{3}\right)}{-40} = \frac{-1}{3} \Rightarrow h_i = -1 \text{ cm}$$

17. (b) : A fan stirrer air in the room which helps in evaporation of our perspiration and due to evaporation cooling is caused, which produces a feeling of comfort.

18. (d) : When a charge is moved from one point to the other over an equipotential surface, work done will be zero.



19. (d) : Let V be the volume of the object.

$$\therefore V(d-d_1)g = m_1g \quad \dots(i)$$

$$\text{and } V(d-d_2)g = m_2g \quad \dots(ii)$$

$$\text{Divide (i) by (ii), we get } \frac{d-d_1}{d-d_2} = \frac{m_1}{m_2}$$

$$m_2d - m_2d_1 = m_1d - m_1d_2$$

$$d(m_1 - m_2) = m_1d_2 - m_2d_1$$

$$d = \frac{m_1d_2 - m_2d_1}{m_1 - m_2}$$

20. (b) : Here, $\frac{I_1}{I_2} = \frac{9}{1}$

$$\therefore \text{Intensity} \propto (\text{Amplitude})^2$$

$$\therefore \frac{I_1}{I_2} = \left(\frac{A_1}{A_2}\right)^2 = \frac{9}{1} \text{ or } \frac{A_1}{A_2} = \sqrt{\frac{9}{1}} = \frac{3}{1}$$

$$\therefore \frac{I_{\max}}{I_{\min}} = \frac{(A_1 + A_2)^2}{(A_1 - A_2)^2} = \frac{\left(\frac{A_1}{A_2} + 1\right)^2}{\left(\frac{A_1}{A_2} - 1\right)^2} = \frac{(3+1)^2}{(3-1)^2} = \frac{16}{4} = \frac{4}{1}$$

21. (b) : Relative velocity of rain with respect to man

$$= \sqrt{3^2 + 10^2} = \sqrt{109} \text{ km/h.}$$

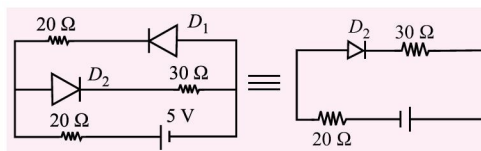
22. (c) : Nuclear density does not depend upon the mass of the nucleus. Hence it is immaterial, whether they are isobars or isotopes and all of them have the same density $d_A = d_B = d_C$.

23. (c) : Work done = Gain in potential energy

$$\text{Area under curve} = mgh$$

$$\Rightarrow \frac{1}{2} \times 11 \times 100 = 5 \times 10 \times h \Rightarrow h = 11 \text{ m}$$

24. (b) : $D_1 \rightarrow$ reverse biased and $D_2 \rightarrow$ forward biased. Equivalent circuit is



Therefore, current through the circuit will be,

$$I = \frac{5 \text{ V}}{(30+20)\Omega} = \frac{5}{50} \text{ A.}$$

25. (d) : As, $\lambda_m T = \text{constant}$ by Wien's displacement law

$$T = \frac{0.3}{5000 \times 10^{-8}} = 6000 \text{ K}$$

26. (b) : For forward bias,

$$I = \frac{V}{R} = \frac{5}{25+10} = \frac{5}{35} = \frac{1}{7} \text{ A.}$$

27. (b) : At A, frequency is n_1 while source is moving away from O.

$$\therefore n_1 < n.$$

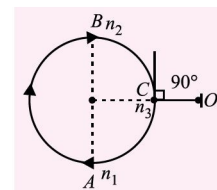
At B, source move towards O,

$$\therefore n_2 > n$$

At C source is at perpendicular to O.

$$\therefore n_3 = n$$

$$\text{Hence } n_2 > n_3 > n_1$$



28. (b) : Since $E = -\frac{13.6}{n^2} \text{ eV}$

$$E_1 = -13.6 \text{ eV}, E_2 = -3.4 \text{ eV}$$

$$E_3 = -1.50 \text{ eV}, E_4 = -0.85 \text{ eV}$$

From above, we can see that $E_3 - E_1 = 12.1 \text{ eV}$

i.e., the electron must be making a transition from $n = 3$ to $n = 1$ level.

$$\Delta L = \left[(n_2 - n_1) \frac{h}{2\pi}\right] = (3-1) \frac{h}{2\pi} = \frac{h}{\pi} = 2.11 \times 10^{-34} \text{ J s}$$

29. (a) : $f' = \frac{v-u}{v} f$; $f'' = \frac{v+u}{v} f$

$$\text{No. of beats} = f'' - f' = 2u \frac{f}{v} = \frac{2u}{\lambda}$$

30. (b) : Induced e.m.f,

$$\epsilon = \frac{-(\phi_2 - \phi_1)}{t} = \frac{-(0 - NBA)}{t} = \frac{NBA}{t}$$

$$t = \frac{NBA}{\epsilon} = \frac{50 \times 2 \times 10^{-2} \times 10^{-2}}{0.1} = 0.1 \text{ s}$$

31. (a) : Given: $\vec{v} = (3\hat{i} + 10\hat{j}) \text{ ms}^{-1}$

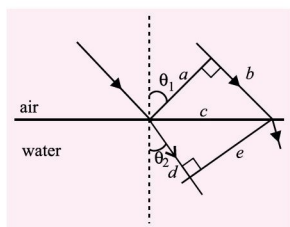
$$\therefore v_x = 3 \text{ m s}^{-1} \text{ and } v_y = 10 \text{ m s}^{-1}$$

$$\text{Maximum height, } H = \frac{v_y^2}{2g} = \frac{(10 \text{ ms}^{-1})^2}{2 \times 10 \text{ ms}^{-2}} = 5 \text{ m}$$

$$\begin{aligned} \text{Range, } R &= v_x \times T_f = v_x \times \frac{2v_y}{g} \\ &= \frac{2v_x v_y}{g} = \frac{2 \times 3 \text{ ms}^{-1} \times 10 \text{ ms}^{-1}}{10 \text{ ms}^{-2}} = 6 \text{ m} \end{aligned}$$

32. (c) : From the Snells law, $1 \sin(90^\circ - \theta_1) = \mu \sin \theta_2$

$$1 \frac{b}{c} = \mu \times \frac{d}{c}; \therefore \mu = \frac{b}{d}$$



33. (a) : When the intensity of light source is increased, a large number of photons are emitted from the light source. Hence option (a) is correct. Due to increase in the number of photons, total energy of the photons emitted per unit time also increases. Increase in the intensity of light increases only the number of photons, not the energy of the photons.

34. (c) : Power P radiated by the sun with its surface temperature $(t + 273)$ is given by Stefan's Boltzmann law.

$$P = \sigma e 4\pi r^2 (t + 273)^4$$

where r is the radius of the Sun and the Sun is treated as a black body where $e = 1$.

The radiant power per unit area received by the surface at a distance R from the centre of the sun is given by

$$S = \frac{P}{4\pi R^2} = \frac{\sigma 4\pi r^2 (t + 273)^4}{4\pi R^2} = \frac{r^2 \sigma (t + 273)^4}{R^2}$$

35. (c) : Zero error = $\frac{5 \times 0.5}{50} = 0.05 \text{ mm}$

$$\begin{aligned} \text{Actual measurement} &= 2 \times 0.5 + \frac{25 \times 0.5}{50} - 0.05 \\ &= 1 + 0.25 - 0.05 = 1.2 \text{ mm} \end{aligned}$$

36. (a,b,d) : Here magnitude of velocity, $|\vec{v}| = \sqrt{8^2 + 6^2} = 10 \text{ m s}^{-1}$

$$\therefore \text{Radius of circular path } r = \frac{mv}{qB} = \frac{10}{2} = 5 \text{ m}$$

As the magnetic field is in z -direction, hence the path of

the charged particle will be circular of radius 5 m in x - y plane; hence options (a) and (b) may be possible.

$$\begin{aligned} \text{So, time period of circular path, } T &= \frac{2\pi r}{v} \\ &= \frac{2\pi \times 5}{10} = \pi \text{ seconds.} \end{aligned}$$

37. (a, c) : Due to a charged non-conducting sphere,

(i) Intensity inside sphere = E_1

$$E_1 = \frac{1}{4\pi\epsilon_0} \frac{Q}{R^3} r$$

$\therefore E_1 \propto r$, for $r < R$, as (OA) in figure.

Option (a) is correct.

(ii) Intensity outside sphere = E_2

$$E_2 = \frac{1}{4\pi\epsilon_0} \frac{Q}{r^2} \text{ when } R < r < \infty$$

$\therefore E_2 \propto \frac{1}{r^2}$, as (AB) in the figure.

$\therefore E_2$ decreases as r increases. Option (c) is correct.

(iii) Option (b) is incorrect in view of (a) and (c) above.

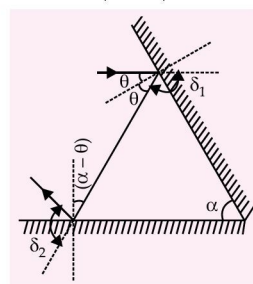
(iv) Intensity at surface = E_0

$$\therefore E_0 = \frac{1}{4\pi\epsilon_0} \frac{Q}{R^2}, \text{ at point A in the figure.}$$

E_0 is continuous at $r = R$. Option (d) is incorrect

38. (a, b, c, d) : (b) Total deviation $\delta = \delta_1 + \delta_2$

$$= (180^\circ - 2\theta) + 180^\circ - 2(\alpha - \theta) = 360^\circ - 2\alpha$$



Which is independent of angle of incidence.

(c) Plane mirror can form real image of virtual object.

(d) Velocity of the image toward the object = $v + v = 2v$.

39. (a, c) : Given $x = x_0 + a \sin \omega t$

$$\therefore v = \frac{dx}{dt} = a\omega \cos \omega t \quad (\text{for block A})$$

at $t = 0$, $x = x_0$ and $v = a\omega$

i.e., block A is at $x = x_0$ (mean position) and its velocity is $a\omega$ in positive x -direction. It collides elastically with an

identical block B moving towards negative x -direction with velocity v_0 .

So, the blocks will interchange their velocities *i.e.*,

$$v_A = v_0 \text{ (in negative } x\text{-direction)}$$

and $v_B = a\omega$ (in positive x -direction)

Let A be the new amplitude of block A , then from conservation of mechanical energy

$$\frac{1}{2}mv_A^2 = \frac{1}{2}kA^2 \therefore A = v_A \sqrt{\frac{m}{k}} = v_0 \sqrt{\frac{m}{k}}$$

$\therefore$ New displacement-time equation for block A will be,

$$x = x_0 - v_0 \sqrt{\frac{m}{k}} \sin \omega t$$

40. (a, c) : When the key is position 1, then current (I) starts flowing through Bulb 1 and there will be no current through Bulb 2. Therefore, Bulb 2 dies. Hence, option (a) is correct.

The maximum current in the inductor, $i_0 = \frac{\varepsilon}{R_2}$

Energy stored in the inductor

$$U = \frac{1}{2}Li_0^2 = \frac{1}{2}L\left(\frac{\varepsilon}{R_2}\right)^2 \Rightarrow \frac{L\varepsilon^2}{2R_2^2}$$

When key is in position 1, this energy will convert into heat energy through resistor. Therefore, option (c) is correct.



Microsoft Bing, OpenAI, and the changing future of search on the Internet

THE DAY after Google announced Bard, its new artificial intelligence (AI) chatbot to take on the challenge of ChatGPT - the AI chatbot developed by the Microsoft-backed startup OpenAI - the Redmond, Washington-based software giant unveiled plans to integrate its Bing search with more AI features, powered by a new and bigger language learning model (LLM) from OpenAI.

Based on what Microsoft showcased at the event, Bing, Microsoft's web search engine, will now be more conversational and interactive, almost like a smart AI assistant, rather than merely providing endless links, which is the case currently.

So how is Bing search changing?

In its new avatar, the search engine will give more conversational answers, in the form of essays and summaries. Yes, it will still show links, but will also give a "summarised answer" on the right, which will be based on "consolidating reliable sources across the web", according to Microsoft's blog post.

The demos suggest that Bing's new chat experience will write poems and stories, and even provide helpful tips on what to do in a particular city- all of which will be designed to make the search seem more personalised.

As of now, this is a limited release - and users have to sign up on the waitlist in order to get access. Once it begins to be rolled out, the Bing search experience will be available on desktop computers and in apps.

Does this mean Bing search is turning into ChatGPT?

Not exactly. For one, Bing search will continue to show links - even in those essay-style answers - at the bottom of the answers. ChatGPT - which in the weeks after its prototype launch late last year was seen to have a semblance of human-like intelligence and appeared to present a sensational peek into both the potentials and the threat of AI - does not, for now, show links. But it would be fair to say Bing is getting a lot of help from OpenAI and the large language models (LLM) that helped create ChatGPT.

Microsoft's blog post notes that the LLM powering Bing is bigger than what is being used to run ChatGPT, although it does not specify exactly how big. This also means Bing's AI chat will have more answers and a larger knowledge pool compared to ChatGPT - where the knowledge is limited to events before 2021.

But Bing's AI chat experience will certainly make it feel more like ChatGPT. Users will also be able to ask "follow-up questions" to their initial question.

The new AI features also apply a "Prometheus model". Microsoft calls this a "proprietary way of working with the OpenAI model" that ensures it can utilise these language models in the best possible manner to give "relevant, timely and targeted result...".

What about the accuracy of answers?

This was a shortcoming that almost all reviews of ChatGPT noted, and Microsoft has cautioned that not all answers would be accurate, given these features are still in early preview, and since the answers are based on information from the web.

The company asked users to rely on their judgment as well. Bing search will let users flag an answer as incorrect if needed, which it said will help in feedback.

According to Microsoft's post, the Bing search experience is designed "to keep humans at the centre, and we have developed a safety system that is designed to mitigate failures and avoid misuse with things like content filtering, operational monitoring and abuse detection, and other safeguards". That's also the reason why the feature is being rolled out in a phased manner.

So will Bing search finally defeat Google?

It is too early to say, but no doubt Microsoft's announcement and the viral interest around ChatGPT likely has Google worried. Having announced Bard, Google was to host an event on AI in Paris later on 8 Feb where it will showcase some new AI products. More details about Bard are also expected at this event Google has promised to bring more AI-based features to its search. Even so, it is fair to say Microsoft has taken the lead in AI-related developments and its announcement will have big implications for Bing, which has never been as popular as Google search. Google has comprehensively dominated the search market for decades - but with AI features that give exact, precise, and interesting answers, the nature of how people search is bound to change. Should Bing and OpenAI continue to improve and scale faster, Google has ample reason to be concerned.

Courtesy : The Indian Express

BRUSH UP *for* NEET/JEE

CLASS-XI

Brush up your concepts to get high rank in NEET/JEE (Main and Advanced) by reading this column. This specially designed column is updated year after year by a panel of highly qualified teaching experts well-tuned to the requirements of these Entrance Tests.

Unit 7

Heat and Thermodynamics / Kinetic Theory of Gases / Oscillations / Waves

HEAT AND THERMODYNAMICS

Thermodynamic Processes

- **Isothermal process** : In this process, P and V changes but T remains constant, i.e., change in temperature $\Delta T = 0$.

In isothermal process, Boyle's law is obeyed by the ideal gas, i.e., $PV = \text{constant} \Rightarrow P_1 V_1 = P_2 V_2$.

- Indicator diagram

Slope of isothermal curve: By differentiating,

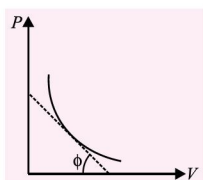
$PV = \text{constant}$, we get

$$PdV + VdP = 0$$

$$\Rightarrow PdV = -VdP$$

$$\therefore \text{Slope} = \tan \theta$$

$$\tan \theta = \frac{dP}{dV} = -\frac{P}{V}$$



- Specific heat of gas during isothermal change is infinite. As $C = \frac{Q}{m\Delta T} = \frac{Q}{m \times 0} = \infty$ ($\because \Delta T = 0$).

- Work done in isothermal process

(i) Area between the isotherm and volume axis represents the work done in isothermal process.

(ii) If volume increases, $\Delta W = +$ (Area under curve) and if volume decreases, $\Delta W = -$ (Area under curve).

$$W = \mu RT \log_e \left(\frac{P_i}{P_f} \right) = 2.303 \mu RT \log_{10} \left(\frac{P_i}{P_f} \right)$$

- First law in isothermal process:

$$\text{From } \Delta Q = \Delta U + \Delta W,$$

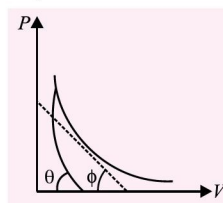
As $\Delta U = 0$ ($\because \Delta T = 0$) $\Rightarrow \Delta Q = \Delta W$
i.e., heat supplied in an isothermal change is used to do work against external surrounding.

- **Adiabatic process** : In this process P , V and T changes but $\Delta Q = 0$.

- In adiabatic change, ideal gases do not obey Boyle's law but obey Poisson's law. According to it,

$$PV^\gamma = \text{constant}; \text{ where } \gamma = \frac{C_p}{C_v}$$

- Indicator diagram



$$\therefore \text{Slope of adiabatic curve, } \tan \phi = -\gamma \left(\frac{P}{V} \right)$$

- Specific heat of a gas during adiabatic change is zero.

$$\therefore C = \frac{\Delta Q}{m\Delta T} = \frac{0}{m\Delta T} = 0 \quad (\text{As } \Delta Q = 0)$$

- Work done in adiabatic process

$$W = \int_{V_i}^{V_f} P dV = \int_{V_i}^{V_f} \frac{K}{V^\gamma} dV$$

$$\Rightarrow W = \frac{(P_i V_i - P_f V_f)}{(\gamma - 1)} = \frac{\mu R(T_i - T_f)}{(\gamma - 1)}$$

$$(\text{As } PV^\gamma = K, P_f V_f = \mu R T_f \text{ and } P_i V_i = \mu R T_i)$$

(i) $W \propto$ quantity of gas

(ii) $W \propto$ temperature difference $(T_i - T_f)$

$$(iii) W \propto \frac{1}{\gamma - 1} \quad \because \gamma_{\text{mono}} > \gamma_{\text{dia}} > \gamma_{\text{tri}}$$

$$\Rightarrow W_{\text{mono}} < W_{\text{dia}} < W_{\text{tri}}$$

- First law in adiabatic process: For adiabatic process, $\Delta Q = 0$

$$\therefore \Delta Q = \Delta U + \Delta W, \quad \therefore \Delta U = -\Delta W$$

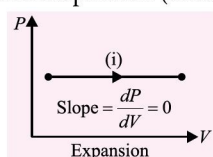
If $\Delta W =$ positive then $\Delta U =$ negative, so temperature decreases, *i.e.*, adiabatic expansion produces cooling.

If $\Delta W =$ negative then $\Delta U =$ positive, so temperature increases, *i.e.*, adiabatic compression produces heating.

- **Isobaric process** : A thermodynamic system undergoes a physical change in such a way that its pressure remains constant.

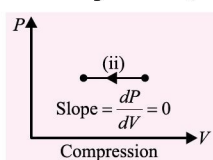
– Indicator diagram

- (i) In isobaric expansion (Heating)



- (a) Temperature increases, so ΔU is positive.
- (b) Volume increases, so ΔW is positive.
- (c) Heat flows into the system, so ΔQ is positive.

- (ii) In isobaric compression (Cooling)



- (a) Temperature decreases, so ΔU is negative.
- (b) Volume decreases, so ΔW is negative.
- (c) Heat flows out from the system, so ΔQ is negative.

– Specific heat of gas during isobaric process,

$$C_p = \left(\frac{f}{2} + 1\right)R; \text{ where } f \text{ is degree of freedom.}$$

– Work done in isobaric process

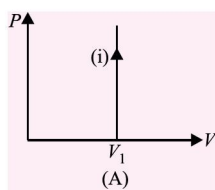
$$\Delta W = P(V_f - V_i) = \mu R(T_f - T_i) = \mu R \Delta T$$

- **Isochoric or Isometric process** : A thermodynamic process undergoes a physical change in such a way that its volume remains constant.

– Slope of indicator diagram $\frac{dP}{dV} = \infty$

- (i) Isometric heating

- (a) Pressure increases
- (b) Temperature increases
- (c) ΔQ positive
- (d) ΔU positive



- (ii) Isometric cooling

- (a) Pressure decreases
- (b) Temperature decreases
- (c) ΔQ negative
- (d) ΔU negative

– Specific heat of gas

$$\text{during isochoric process, } C_v = \frac{f}{2}R$$

– Work done in isochoric process

$$\Delta W = P \Delta V = P(V_f - V_i) = 0 \quad (\text{As } V = \text{constant})$$

- **Cyclic and non-cyclic processes** : A cyclic process consists of a series of changes which return the system back to its initial state. In non-cyclic process, the series of changes involved do not return the system back to its initial state.

In case of cyclic process as $U_f = U_i$

$$\Rightarrow \Delta U = U_f - U_i = 0 \text{ i.e., change in internal energy for cyclic process is zero and also } \Delta U \propto \Delta T$$

$$\Rightarrow \Delta T = 0, \text{ i.e., temperature of system remains constant.}$$

KINETIC THEORY

Degrees of Freedom

Degrees of freedom can be calculated as, $f = 3N - K$, where f = degree of freedom, N = number of independent particles, K = number of constraint.

- (a) For monatomic gas

$$f = 3 \times 1 - 0 = 3 \Rightarrow f = 3 \text{ (all translational)}$$

- (b) For diatomic gas

$$f = 3 \times 2 - 1 = 5 \Rightarrow f = 5 \text{ (3 translational and 2 rotational)}$$

- (c) For triatomic gas

$$(i) \text{ Linear } f = 3 \times 3 - 2 = 7 \Rightarrow f = 7$$

$$(ii) \text{ Non linear } f = 3 \times 3 - 3 = 6 \Rightarrow f = 6 \text{ (3 translational and 3 rotational)}$$

Law of Equipartition of Energy (Boltzmann Law)

The average KE per molecule of a gas per degree of freedom $= \frac{1}{2}k_B T$, where k_B is Boltzmann constant and

T is the absolute temperature in kelvin.

For monatomic gas

– Average KE per molecule of a gas $= \frac{3}{2}k_B T$

– Average KE per mole of a gas

$$= \left(\frac{3}{2}k_B T\right)N = \frac{3}{2}RT$$

- Molar specific heat of gas at constant volume,

$$C_V = \frac{3}{2}R$$

- Molar specific heat of gas at constant pressure,

$$C_P = C_V + R = \frac{3}{2}R + R = \frac{5}{2}R, \quad \gamma = \frac{C_P}{C_V} = \frac{5}{3}$$

For diatomic gas

- Average KE per molecule of gas = $\frac{5}{2}k_B T$

- Average KE per mole of gas = $\frac{5}{2}RT$

- Molar specific heat of gas at constant volume

$$C_V = \frac{5}{2}R$$

- Molar specific heat of gas at constant pressure

$$C_P = C_V + R = \frac{5}{2}R + R = \frac{7}{2}R, \quad \gamma = \frac{C_P}{C_V} = \frac{7}{5}$$

For triatomic gas

- Average KE per molecule of a gas = $\frac{6}{2}k_B T = 3k_B T$

- Average KE per mole of a gas = $3RT$

- Molar specific heat of gas at constant volume

$$C_V = 3R$$

- Molar specific heat of gas at constant pressure

$$C_P = 3R + R = 4R, \quad \gamma = \frac{C_P}{C_V} = \frac{4}{3}$$

OSCILLATIONS

Damped and Forced Oscillations

- The differential equation of damped harmonic oscillator is given by $m \frac{d^2x}{dt^2} + b \frac{dx}{dt} + kx = 0$.

- The displacement of the damped oscillator at any instant t is given by $x(t) = Ae^{-bt/2m} \sin(\omega' t + \phi)$.

- Angular frequency of the damped oscillation

$$\omega' = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}, \text{ where } b \text{ is damping constant.}$$

- Mechanical energy of the damped oscillator $E(t) = \frac{1}{2}kA^2 e^{-bt/m}$.

- The differential equation of forced damped harmonic oscillator is given by

$$m \frac{d^2x}{dt^2} + b \frac{dx}{dt} + kx = F_0 \sin \omega_d t.$$

- where ω_d is the angular frequency of the external force.

- The displacement of the forced damped harmonic oscillator at any instant t is given by

$$x(t) = A \sin(\omega_d t - \phi) \text{ and } \phi = \tan^{-1} \left[\frac{b\omega}{m(\omega^2 - \omega_d^2)} \right]^d.$$

- Amplitude of forced oscillations when driving frequency is far from natural frequency,

$$A = \frac{F_0}{m(\omega^2 - \omega_d^2)}$$

- When driving frequency is close to natural frequency, i.e., at resonance, $A = \frac{F_0}{\omega_d b}$

WAVES

Speed of a Travelling Wave

As the wave moves, each point of the moving waveform represents a particular phase of the wave and retains its displacement y . Therefore in the displacement relation an argument of sine must be a constant.

Since, $(kx - \omega t)$ is a constant,

$$\frac{d}{dt}(kx - \omega t) = 0 \quad \text{or} \quad k \frac{dx}{dt} - \omega = 0 \quad \text{or} \quad \frac{dx}{dt} = \frac{\omega}{k}$$

$$\therefore \text{ wavespeed, } v = \frac{\omega}{k} = \frac{\lambda}{T} = \lambda \nu$$

- **Speed of transverse wave in a stretched string :** Speed of transverse wave depends on two factors.

(i) Linear mass density (μ) and

(ii) Tension in the string (F) as, $v = \sqrt{\frac{F}{\mu}}$

- **Speed of a longitudinal wave (sound wave) :** Speed of a longitudinal wave depends on two factors.

(i) Bulk modulus of the medium (B) and

(ii) Density of the medium (ρ) as,

$$v = \sqrt{\frac{B}{\rho}},$$

- **Speed of longitudinal wave in a solid rod**

$$v = \sqrt{\frac{Y}{\rho}}, \text{ where } Y = \text{Young's modulus of the rod}$$

- **Newton's formula for speed of sound in an ideal gas**

$$v = \sqrt{\frac{P}{\rho}} \text{ where, } P = \text{pressure, } \rho = \text{density}$$

- Modified Newton's formula for speed of sound in an ideal gas from Laplace correction

$$v = \sqrt{\frac{\gamma P}{\rho}}, \text{ where } \gamma = \frac{C_P}{C_V} \text{ for air } \gamma = 7/5$$

$$\therefore v \text{ (at STP)} = 331.3 \text{ m s}^{-1}$$

Standing Waves or Stationary Waves

Any stationary wave can be formed by the addition of two travelling waves moving in opposite direction having same amplitude, frequency, wavelength and speed.

A wave moving in one direction reflects at a barrier and interferes with the incoming wave :

$$y_1(x, t) = a \sin(kx - \omega t)$$

$$y_2(x, t) = a \sin(\omega t + kx)$$

Principle of superposition gives

$$y(x, t) = y_1(x, t) + y_2(x, t) = a \sin(kx - \omega t) + a \sin(kx + \omega t)$$

$$y(x, t) = 2a \sin kx \cos \omega t$$

This is the required equation for standing wave.

Here, $\cos \omega t$ shows varying amplitude with time at a particular place and $\sin kx$ shows a varying amplitude with position at a particular time.

- When, $kx = 0, \pi, 2\pi, \dots, n\pi$

$$\Rightarrow x = 0, \frac{\lambda}{2}, \lambda, \frac{3\lambda}{2}, 2\lambda, \dots, \frac{n\lambda}{2}$$

These positions of zero amplitude are called nodes.

- When, $kx = \pi/2, 3\pi/2, 5\pi/2, \dots, (n + 1/2)\pi/2$ {for integers $n = 0, 1, 2, 3, \dots$ }

$$\Rightarrow x = \lambda/4, 3\lambda/4, 5\lambda/4, \dots, \left(n + \frac{1}{2}\right)\frac{\lambda}{2}$$

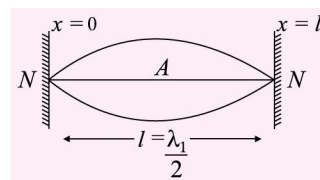
These positions of maximum amplitude are called antinodes.

Stationary Waves in a String Fixed at both Ends

Consider a string of length l , stretched under tension F between two fixed points. If the string is plucked and released, the incident and reflected wave superimposed to produce stationary waves in the string.

- Nodes (N) formed at rigid end and antinodes (A) formed in between them.
- Number of nodes = 1 + number of antinodes.
- Velocity of wave $v = \sqrt{\frac{F}{m}}$; m = mass per unit length

- Frequency of vibrations $v = \frac{1}{\lambda} \sqrt{\frac{F}{m}}$



- Wavelength $\lambda = \frac{2l}{n}$

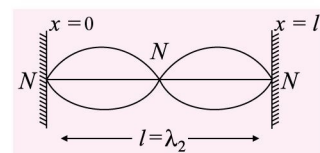
- Fundamental mode or first mode of vibration ($n = 1$)**

$$\lambda_1 = 2l \Rightarrow v_1 = \frac{1}{\lambda_1} \sqrt{\frac{F}{m}} = \frac{1}{2l} \sqrt{\frac{F}{m}}$$

This frequency is called fundamental frequency or first harmonic.

- Second mode of vibration ($n = 2$)**

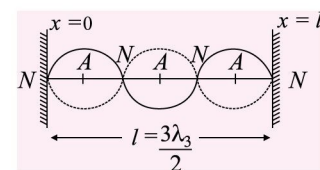
$$\lambda_2 = l \Rightarrow v_2 = \frac{1}{\lambda_2} \sqrt{\frac{F}{m}} = \frac{1}{l} \sqrt{\frac{F}{m}} = 2v_1$$



This frequency is called second harmonic or first overtone.

- Third mode of vibration ($n = 3$)**

$$\lambda_3 = \frac{2l}{3} \Rightarrow v_3 = \frac{1}{\lambda_3} \sqrt{\frac{F}{m}} = \frac{3}{2l} \sqrt{\frac{F}{m}} = 3v_1$$



This frequency is called third harmonic or second overtone

- In general,**

$$\text{Position of nodes, } x = 0, \frac{l}{n}, \frac{2l}{n}, \frac{3l}{n}, \dots, l$$

Position of antinodes

$$x = \frac{l}{2n}, \frac{3l}{2n}, \frac{5l}{2n}, \dots, \frac{(2n-1)l}{2n}$$



WRAP it up!

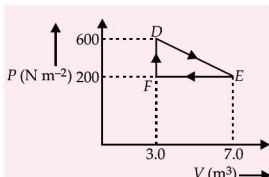
1. A diatomic gas which has initial volume of 10 litre is isothermally compressed to $1/15^{\text{th}}$ of its original volume where initial pressure is 10^5 pascal. If temperature is 27°C then find the work done by gas.

(a) $-2.70 \times 10^3 \text{ J}$ (b) $2.70 \times 10^3 \text{ J}$
(c) $-1.35 \times 10^3 \text{ J}$ (d) $1.35 \times 10^3 \text{ J}$

2. One mole of an ideal monoatomic gas undergoes a process described by the equation $PV^3 = \text{constant}$. The heat capacity of the gas during this process is

(a) $\frac{3}{2}R$ (b) $\frac{5}{2}R$ (c) $2R$ (d) R

3. A thermodynamic process is carried out from an original state D to an intermediate state E by the linear process shown in figure.



The total work done by the gas from D to E to F is

(a) 100 J (b) 800 J (c) 300 J (d) 250 J

4. A Carnot engine operates with source at 127°C and sink at 27°C . If the source supplies 40 kJ of heat energy, the work done by the engine is

(a) 30 kJ (b) 10 kJ (c) 4 kJ (d) 1 kJ

5. The coefficient of performance of a refrigerator is 5. If the temperature inside freezer is -20°C , the temperature of the surroundings to which it rejects heat is

(a) 11°C (b) 21°C (c) 31°C (d) 41°C

6. The molecules in an ideal gas at 27°C have a certain mean velocity. At what approximate temperature, (in $^\circ\text{C}$) will the mean velocity be doubled?

(a) 54 (b) 327 (c) 1200 (d) 927

7. The value of $\gamma \left(= \frac{C_p}{C_v} \right)$, for hydrogen, helium and another ideal diatomic gas X (whose molecules are not rigid but have an additional vibrational mode), are respectively equal to

(a) $\frac{7}{5}, \frac{5}{3}, \frac{9}{7}$ (b) $\frac{5}{3}, \frac{7}{5}, \frac{9}{7}$

(c) $\frac{5}{3}, \frac{7}{5}, \frac{7}{5}$

(d) $\frac{7}{5}, \frac{5}{3}, \frac{7}{5}$

8. Two mole of oxygen is mixed with eight mole of helium. The effective specific heat of the mixture at constant volume is

(a) $1.3R$ (b) $1.4R$ (c) $1.7R$ (d) $1.9R$

9. The average degree of freedom per molecule for a gas is 6. The gas performs 25 J of work when it expands at constant pressure. The heat absorbed by the gas is

(a) 75 J (b) 100 J (c) 150 J (d) 125 J

10. The molar specific heats of an ideal gas at constant pressure and volume are denoted by C_p and C_v , respectively. If $\gamma = \frac{C_p}{C_v}$ and R is the universal gas constant, then C_v is equal to

(a) $\frac{(\gamma-1)}{R}$ (b) γR (c) $\frac{1+\gamma}{1-\gamma}$ (d) $\frac{R}{(\gamma-1)}$

11. Two particles execute SHM of the same amplitude and frequency along the same line. They pass one another when going in opposite directions each time their displacement is half their amplitude. What is the phase difference between them?

(a) 60° (b) 120° (c) 160° (d) 180°

12. Two simple harmonic motions are represented by

$$y_1 = 10[\sin 2\pi t + \sqrt{3} \cos 2\pi t] \text{ and } y_2 = 5 \sin \left(2\pi t + \frac{\pi}{4} \right).$$

The ratio of their amplitudes is

(a) 1 : 1 (b) 4 : 1 (c) 1 : 3 (d) $\sqrt{3} : 1$

13. The time period of a particle undergoing SHM is 16 s. It starts motion from the mean position. After 2 s, its velocity is 0.4 m s^{-1} . The amplitude is

(a) 1.44 m (b) 0.72 m (c) 2.88 m (d) 0.36 m

14. If the ratio of the mechanical energy of a mass whose oscillations are damped to that of its free oscillations is $e^{-3t/m}$, then the ratio of the amplitudes of the damped oscillations to that of free oscillations is

(a) $e^{-\frac{3t}{m}}$ (b) $e^{-\frac{3t}{2m}}$ (c) $e^{-\frac{6t}{m}}$ (d) $e^{-\frac{3t}{\sqrt{2}m}}$

15. The damping force on an oscillator is directly proportional to the velocity. The units of the constant of proportionality are
(a) kg m s^{-1} (b) kg m s^{-2} (c) kg s^{-1} (d) kg s
16. A uniform rope of length L and mass m_1 hangs vertically from a rigid support. A block of mass m_2 is attached to the free end of the rope. A transverse pulse of wavelength λ_1 is produced at the lower end of the rope. The wavelength of the pulse when it reaches the top of the rope is λ_2 . The ratio λ_2/λ_1 is
(a) $\sqrt{\frac{m_2}{m_1}}$ (b) $\sqrt{\frac{m_1 + m_2}{m_1}}$
(c) $\sqrt{\frac{m_1}{m_2}}$ (d) $\sqrt{\frac{m_1 + m_2}{m_2}}$
17. Two strings A and B of same material are stretched by same tension. The radius of the string A is double the radius of string B. Transverse wave travels on string A with speed V_A and on string B with speed V_B . The ratio V_A/V_B is
(a) $1/4$ (b) $1/2$ (c) 2 (d) 4
18. The velocity of sound in air at 20°C and 1 atm pressure is 344.2 m/s. At 40°C and 2 atm pressure, the velocity of sound (in m/s) in air is approximately
(a) 350 (b) 356 (c) 363 (d) 370
19. In a sonometer experiment, the string of length L under tension vibrates in second overtone between two bridges. The amplitude of vibration is maximum at
(a) $\frac{L}{3}, \frac{2L}{3}, \frac{5L}{6}$ (b) $\frac{L}{8}, \frac{L}{4}, \frac{L}{2}$
(c) $\frac{L}{2}, \frac{L}{4}, \frac{L}{6}$ (d) $\frac{L}{6}, \frac{L}{2}, \frac{5L}{6}$
20. Two uniform wires of the same material are vibrating under the same tension. If the first overtone of the first wire is equal to the second overtone of the second wire and radius of the first wire is twice the radius of the second wire then the ratio of the lengths of the first wire to second wire is
(a) $1/3$ (b) $1/4$ (c) $1/5$ (d) $1/6$

SOLUTIONS

1. (a): $W = nRT \ln\left(\frac{V_2}{V_1}\right) = P_0 V_0 \ln\left(\frac{V_2}{V_1}\right)$
 $= 10^5 \times 10 \times 10^{-3} \ln\left(\frac{1}{15}\right) = -2.70 \times 10^3 \text{ J}$

2. (d): Process described by the equation, $PV^3 = \text{constant}$

For a polytropic process, $PV^\alpha = \text{constant}$

$$C = C_V + \frac{R}{1-\alpha} = \frac{3}{2}R + \frac{R}{1-3} = R \quad (\because \alpha = 3)$$

3. (b): The total work done by the gas from D to E to F is equal to the area of $\triangle DEF$.

$$\therefore \text{Area of } \triangle DEF = \frac{1}{2} DF \times EF$$

Here, $DF = \text{change in pressure} = 600 - 200 = 400 \text{ N m}^{-2}$
 and $EF = \text{change in volume} = 7 \text{ m}^3 - 3 \text{ m}^3 = 4 \text{ m}^3$

$$\therefore \text{Area of } \triangle DEF = \frac{1}{2} \times 400 \times 4 = 800 \text{ J}$$

4. (b): Efficiency, $\eta = 1 - \frac{T_2}{T_1}$; $\eta = 1 - \frac{300}{400} = 1 - \frac{3}{4} = \frac{1}{4}$

$$\text{Also } \eta = \frac{\text{Work done by engine}}{\text{Heat supplied by source}} = \frac{W}{40 \text{ kJ}}$$

$$\therefore W = 40\eta = 40 \times \frac{1}{4} = 10 \text{ kJ}$$

5. (c): The coefficient of performance of a refrigerator is $\beta = \frac{T_2}{T_1 - T_2}$, where T_1 and T_2 are the temperatures of

hot and cold reservoirs (in kelvin) respectively.

Here, $\beta = 5$, $T_2 = -20^\circ\text{C} = -20 + 273 = 253 \text{ K}$, $T_1 = ?$

$$\therefore 5 = \frac{253 \text{ K}}{T_1 - 253 \text{ K}} \text{ or } T_1 \approx 31^\circ\text{C}$$

6. (d): Mean velocity of gas molecules is $\bar{v} = \sqrt{\frac{8RT}{\pi M}}$
 For the same gas, $\bar{v} \propto \sqrt{T}$

$$\therefore \frac{\bar{v}_1}{\bar{v}_2} = \sqrt{\frac{T_1}{T_2}} \text{ or } \frac{\bar{v}_1}{2\bar{v}_1} = \sqrt{\frac{300}{T_2}}$$

Squaring both sides, we get

$$\frac{1}{4} = \frac{300}{T_2} \text{ or } T_2 = 1200 \text{ K} = 1200 - 273 = 927^\circ\text{C}$$

7. (a): $\gamma = 1 + \frac{2}{n}$; For H_2 , $\gamma = 1 + \frac{2}{5} = \frac{7}{5}$

For He , $\gamma = 1 + \frac{2}{3} = \frac{5}{3}$; For X , $\gamma = 1 + \frac{2}{7} = \frac{9}{7}$

8. (c): For mixture of gases, $C_V = \frac{n_1 C_{V1} + n_2 C_{V2}}{n_1 + n_2}$

Here, $C_{V1} = \frac{5}{2}R$, $C_{V2} = \frac{3}{2}R$

$$\therefore C_V = \frac{2 \times \frac{5}{2}R + 8 \times \frac{3}{2}R}{2+8} = \frac{17}{10}R = 1.7R$$

9. (b): $\gamma = 1 + \frac{2}{f} = 1 + \frac{2}{6} = \frac{4}{3}$

$$\frac{\Delta W}{\Delta Q} = \frac{\Delta Q - \Delta U}{\Delta Q} = 1 - \frac{\Delta U}{\Delta Q} = 1 - \frac{nC_V \Delta T}{nC_P \Delta T}$$

$$= 1 - \frac{1}{\gamma} = 1 - \frac{3}{4} = \frac{1}{4} \quad \left(\because \frac{C_P}{C_V} = \gamma \right)$$

$$\therefore \Delta Q = 4\Delta W = 100 \text{ J}$$

10. (d): For an ideal gas, $C_P - C_V = R$

Divide C_V on both sides, we get

$$\frac{C_P}{C_V} - 1 = \frac{R}{C_V}$$

$$\text{As } \gamma = \frac{C_P}{C_V} \quad \therefore \gamma - 1 = \frac{R}{C_V} \text{ or } C_V = \frac{R}{\gamma - 1}$$

11. (b): Displacement of a particle executing SHM at any instant is given by $y = A \sin(\omega t + \phi)$

$$\text{When } y = \frac{A}{2}; \quad \frac{A}{2} = A \sin(\omega t + \phi)$$

$$\text{or } \sin(\omega t + \phi) = \frac{1}{2} = \sin \frac{\pi}{6} = \sin \frac{5\pi}{6}$$

So, phase of two particles is $\frac{\pi}{6}$ and $\frac{5\pi}{6}$ radians.

Hence, phase difference between them

$$= \frac{5\pi}{6} - \frac{\pi}{6} = \frac{2\pi}{3} \text{ radians or } 120^\circ$$

$$\textbf{12. (b):} \text{ Here, } y_1 = 10 \left[\sin 2\pi t + \sqrt{3} \cos 2\pi t \right]$$

$$= 20 \left[\frac{1}{2} \sin 2\pi t + \frac{\sqrt{3}}{2} \cos 2\pi t \right]$$

$$= 20 \left[\cos \frac{\pi}{3} \sin 2\pi t + \sin \frac{\pi}{3} \cos 2\pi t \right]$$

$$= 20 \left[\sin \left(2\pi t + \frac{\pi}{3} \right) \right]$$

$$\therefore A_1 = 20 \text{ and } y_2 = 5 \sin \left(2\pi t + \frac{\pi}{4} \right); A_2 = 5$$

$$\text{Hence } \frac{A_1}{A_2} = \frac{20}{5} = \frac{4}{1}$$

13. (a): Velocity, $v = r\omega \cos \omega t$

$$0.4 = r \times \frac{2\pi}{16} \cos \frac{2\pi}{16} \times 2 = r \times \frac{2\pi}{16} \times \frac{1}{\sqrt{2}} \Rightarrow r = 1.44 \text{ m}$$

14. (b): If E and E_0 represent the mechanical energy of the damped and free oscillations respectively, then as

$$\text{per question } \frac{E}{E_0} = e^{-3t/m}$$

As mechanical energy $\propto (\text{amplitude})^2$

$\therefore$ The ratio of the amplitudes of the damped oscillations to that of free oscillations is

$$\frac{A}{A_0} = \left(\frac{E}{E_0} \right)^{1/2} = (e^{-3t/m})^{1/2} = e^{-3t/2m}$$

15. (c): Damping force, $F \propto v$ or $F = kv$ where k is the constant of proportionality

$$\therefore k = \frac{F}{v} = \frac{\text{N}}{\text{m s}^{-1}} = \frac{\text{kg m s}^{-2}}{\text{m s}^{-1}} = \text{kg s}^{-1}$$

16. (d): Wavelength of pulse at the lower

$$\text{end } (\lambda_1) \propto \text{velocity } (v_1) = \sqrt{\frac{T_1}{\mu}}$$

$$\text{Similarly, } \lambda_2 \propto v_2 = \sqrt{\frac{T_2}{\mu}}$$

$$\therefore \frac{\lambda_2}{\lambda_1} = \sqrt{\frac{T_2}{T_1}} = \sqrt{\frac{(m_1 + m_2)g}{m_2 g}} = \sqrt{\frac{m_1 + m_2}{m_2}}$$

17. (b): Velocity of transverse wave on a string is given

$$\text{by; } V_t = \sqrt{\frac{T}{m}}$$

where m = linear mass density of string

$$= \frac{M}{l} = \frac{\rho V}{l} = \frac{\rho \pi r^2 l}{l} = \rho \pi r^2$$

$$\therefore V_t = \sqrt{\frac{T}{\rho \pi r^2}} = \frac{1}{r} \sqrt{\frac{T}{\rho \pi}}$$

Since T and ρ are same for both strings,

$$\therefore \frac{V_A}{V_B} = \frac{r_B}{r_A} = \frac{1}{2} \quad (\text{given, } r_A = 2r_B)$$

$$\textbf{18. (b):} \text{ Velocity of sound in air, } v = \sqrt{\frac{\gamma RT}{M}}$$

For a given medium, $v \propto \sqrt{T}$

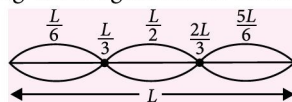
$$\frac{v_1}{v_2} = \sqrt{\frac{T_1}{T_2}}$$

$$\text{Here, } v_1 = 344.2 \text{ m s}^{-1}, T_1 = 20^\circ \text{C} = 293 \text{ K}$$

$$T_2 = 40^\circ \text{C} = 313 \text{ K}$$

$$\therefore v_2 = v_1 \sqrt{\frac{T_2}{T_1}} = (344.2) \times \sqrt{\frac{313}{293}} = 355.75 \approx 356 \text{ m s}^{-1}$$

19. (d): String vibrating in second overtone

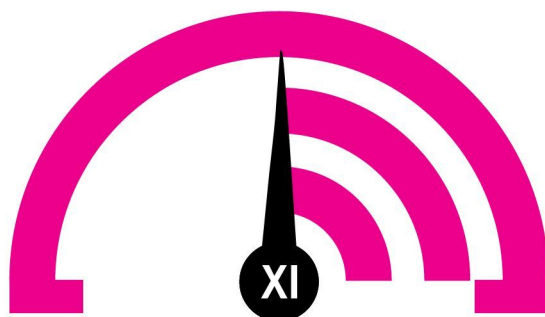


So, the amplitude of vibration is maximum at $\frac{L}{6}, \frac{L}{2}, \frac{5L}{6}$

20. (a)



MONTHLY TEST DRIVE



This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Time Taken : 60 Min.

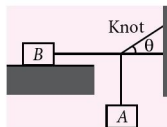
Laws of Motion

Total Marks : 120

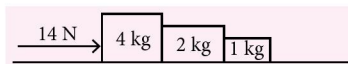
NEET

Simple Option Correct

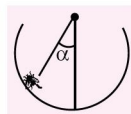
- A lift is moving down with acceleration a . A man in the lift drops a ball inside the lift. The acceleration of the ball as observe by the man in the lift and a man standing stationary on the ground are respectively.
(a) g, g (b) $g - a, g - a$
(c) $g - a, g$ (d) a, g
- Block B lying on a table weighs W . The coefficient of static friction between the block and the table is μ . Assume that the cord between B and the knot is horizontal. The maximum weight of the block A for which the system will be stationary is
(a) $\frac{W \tan \theta}{\mu}$ (b) $\mu W \tan \theta$
(c) $\mu W \sqrt{1 + \tan^2 \theta}$ (d) $\mu W \sin \theta$
- A car moves around a curved road of radius R_1 at constant speed v without sliding. If we double the car's speed, what is the least radius that would now keep the car from sliding?
(a) $2R_1$ (b) $4R_1$ (c) $6R_1$ (d) R_1
- A mass of 1 kg is suspended by means of a thread. The system is (i) lifted up with an acceleration of 4.9 m/s^2 (ii) lowered with an acceleration of 4.9 m/s^2 . The ratio of tension in the first and second case is
(a) 3 : 1 (b) 1 : 2 (c) 1 : 3 (d) 2 : 1.
- A thick uniform rope of mass 6 kg and length 3 m is hanging vertically from a rigid support. The tension in the rope at a point 1 m from the support will be
(a) 20 N (b) 30 N (c) 40 N (d) 60 N



- Three blocks of mass 4 kg, 2 kg, 1 kg respectively are in contact on a frictionless table as shown in the figure. If a force of 14 N is applied on the 4 kg block, the contact force between the 4 kg and the 2 kg block will be



- (a) 2 N (b) 6 N (c) 8 N (d) 14 N
- A particle of mass m is acted upon by a force F given by the empirical law $F = \frac{R}{t^2} v(t)$. If this law is to be tested experimentally by observing the motion starting from rest, the best way is to plot
(a) $\log v(t)$ against $\frac{1}{t}$ (b) $v(t)$ against t^2
(c) $\log v(t)$ against $\frac{1}{t^2}$ (d) $\log v(t)$ against t
 - An insect crawls up a hemispherical surface very slowly as shown in figure. The co-efficient of friction between the insect and the surface is $1/3$. If the line joining the center of the hemispherical surface to the insect makes an angle α with the vertical, the maximum possible value of α is given by
(a) $\cot \alpha = 3$ (b) $\tan \alpha = 3$
(c) $\sec \alpha = 3$ (d) $\text{cosec } \alpha = 3$.
 - A car is moving in a circular horizontal track of radius 10 m with a constant speed of 10 m/s. A plumb bob is suspended from the roof of the car by a light rigid rod. The angle made by the rod with the track is ($g = 10 \text{ m/s}^2$).
(a) zero (b) 30° (c) 45° (d) 60°



10. **Assertion :** Two bodies of masses M and m ($M > m$) are allowed to fall from the same height if the air resistance for each be the same then both the bodies will reach the earth simultaneously.

Reason : For same air resistance, acceleration of both the bodies will be same.

- (a) If both assertion and reason are true and reason is the correct explanation of assertion.
 (b) If both assertion and reason are true but reason is not the correct explanation of assertion.
 (c) If assertion is true but reason is false.
 (d) If both assertion and reason are false.
11. A tube of length L is filled completely with an incompressible liquid of mass M and closed at both ends. The tube is rotated in a horizontal plane about one of its ends with a uniform angular velocity ω . The force exerted by the liquid at the other end is

- (a) $\frac{1}{2}M\omega^2L$ (b) $M\omega^2L$
 (c) $\frac{1}{4}M\omega^2L$ (d) $\frac{1}{6}M\omega^2L$

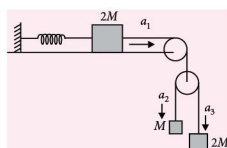
12. A balloon with mass m is descending down with an acceleration a (where $a < g$). How much mass should be removed from it so that it starts moving up with an acceleration a ?

- (a) $\frac{2ma}{g+a}$ (b) $\frac{2ma}{g-a}$ (c) $\frac{ma}{g+a}$ (d) $\frac{ma}{g-a}$

13. A small ball of mass m is thrown upward with velocity u from the ground. The ball experiences a resistive force mkv^2 where v is its speed. The maximum height attained, by the ball is

- (a) $\frac{1}{k} \ln \left(1 + \frac{ku^2}{2g} \right)$ (b) $\frac{1}{k} \tan^{-1} \frac{ku^2}{2g}$
 (c) $\frac{1}{2k} \tan^{-1} \frac{ku^2}{g}$ (d) $\frac{1}{2k} \ln \left(1 + \frac{ku^2}{g} \right)$

14. A block of mass $2M$ is attached to a massless spring with spring-constant k . This block is connected to two other blocks of masses M and $2M$ using two massless pulleys and strings. The accelerations of the blocks are a_1 , a_2 and a_3 as shown in the figure. The system is released from



rest with the spring in its unstretched state. The maximum extension of the spring is x_0 . Which of the following option(s) is/are correct? [g is the acceleration due to gravity. Neglect friction]

- (a) At an extension of $x_0/4$ of the spring, the magnitude of acceleration of the block connected to the spring is $3g/10$

(b) $x_0 = \frac{4Mg}{k}$

- (c) When spring achieves an extension of $x_0/2$ for the first time, the speed of the block connected

to the spring is $3g\sqrt{\frac{M}{5k}}$

(d) $a_2 - a_1 = a_1 - a_3$

15. A piece of wire is bent in the shape of a parabola $y = kx^2$ (y -axis vertical) with a bead of mass m on it. The bead can slide on the wire without friction. It stays at the lowest point of the parabola when the wire is at rest. The wire is now accelerated parallel to the x -axis with a constant acceleration a . The distance of the new equilibrium position of the bead, where the bead can stay at rest with respect to the wire, from the y -axis is

- (a) $\frac{a}{gk}$ (b) $\frac{a}{2gk}$ (c) $\frac{2a}{gk}$ (d) $\frac{a}{4gk}$



14th
March

Founded in 1988 by physicist Larry Shaw, March 14 was selected **because the numerical date (3.14) represents the first three digits of pi, and it also happens to be Albert Einstein's birthday.**

The first-time scientists had found it "lurking" in the world of Physics, when using quantum mechanics to compare the energy levels of a hydrogen atom.

The discovery was made when Carl Hagen, a particle physicist at the University of Rochester, was teaching a class on quantum mechanics and explaining to his students how to use a quantum mechanical technique known as the 'variation principle' to approximate the energy states of a hydrogen atom.

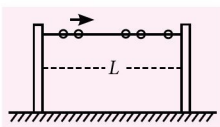
While comparing these values to conventional calculations, he noticed an unusual trend in the ratios. He asked Alexander Friedmann (A Russian physicist and mathematician best known for his work on theory of relativity) to help him work out this trend, and they quickly realised that it was actually a manifestation of the Wallis formula for π - the first time it had even been derived from Physics. He got the Wallis formula out of equations for the hydrogen atom.

This almost seems like magic, "that a formula for π is hidden inside the quantum mechanics of the hydrogen atom is surprising and delightful.

16. A block of mass m is placed on a surface with a vertical cross section given by $y = \frac{x^3}{6}$. If the coefficient of friction is 0.5, the maximum height above the ground at which the block can be placed without slipping is

(a) $\frac{1}{2}$ m (b) $\frac{1}{6}$ m (c) $\frac{2}{3}$ m (d) $\frac{1}{3}$ m

17. A large number (n) of identical beads, each of mass m and radius r are strung on a thin smooth rigid horizontal rod of length L ($L \gg r$) and are at rest at random positions. The rod is mounted between two rigid supports (see figure). If one of the beads is now given a speed v , the average force experienced by each support after a long time is (assume all collisions are elastic)



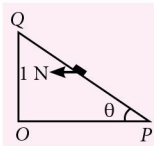
(a) $\frac{mv^2}{L - nr}$ (b) $\frac{mv^2}{L - 2nr}$
(c) $\frac{mv^2}{2(L - nr)}$ (d) zero

18. A light spring balance hangs from the hook of the other light spring balance and a block of mass M kg hangs from the former one. Then, the true statement about the scale reading is
- (a) Both the scales read M kg each
(b) The scale of the lower one reads M kg and of the upper one zero.
(c) The reading of the two scales can be anything but the sum of the readings will be M kg
(d) Both the scales read $M/2$ kg.

JEE MAIN / ADVANCED

More than one option correct type

19. A small block of mass of 0.1 kg lies on a fixed inclined plane PQ which makes an angle θ with the horizontal. A horizontal force of 1 N acts on the block through its center of mass as shown in the figure. The block remains stationary if (take $g = 10 \text{ m/s}^2$)



- (a) $\theta = 45^\circ$
(b) $\theta > 45^\circ$ and a frictional force acts on the block towards P .
(c) $\theta > 45^\circ$ and a frictional force acts on the block towards Q .

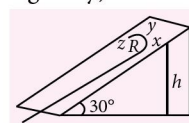
- (d) $\theta < 45^\circ$ and a frictional force acts on the block towards Q .

20. A reference frame attached to the earth
- (a) is an inertial frame by definition.
(b) cannot be an inertial frame because the earth is revolving round the sun.
(c) is an inertial frame because Newton's laws are applicable in this frame.
(d) cannot be an inertial frame because the earth is rotating about its own axis.

21. The ball, having linear momenta $\vec{p}_1 = p\hat{i}$ and $\vec{p}_2 = p\hat{i}$ undergo a collision in free space. There is no external force acting on the balls. Let $\vec{p}'_1$ and $\vec{p}'_2$ be their final momenta. The following option(s) is (are) not allowed for any non-zero value of p , a_1 , a_2 , b_1 , b_2 , c_1 and c_2 .

- (a) $\vec{p}'_1 = a_1\hat{i} + b_1\hat{j} + c_1\hat{k}$; $\vec{p}'_2 = a_1\hat{i} + b_2\hat{j}$
(b) $\vec{p}'_1 = c_1\hat{k}$; $\vec{p}'_2 = c_2\hat{k}$
(c) $\vec{p}'_1 = a_1\hat{i} + b_1\hat{j} + c_1\hat{k}$; $\vec{p}'_2 = a_2\hat{i} + b_2\hat{j} - c_1\hat{k}$
(d) $\vec{p}'_1 = a_1\hat{i} + b_1\hat{j}$; $\vec{p}'_2 = a_2\hat{i} + b_1\hat{j}$

22. A student skates up a ramp that makes angle 30° with the horizontal. He/she starts (as shown in the figure) at the bottom of the ramp with speed v_0 and wants to turn around over a semicircular path xyz of radius R during which he/she reaches a maximum height h (at point y) from the ground as shown in the figure. Assume that the energy loss is negligible and the force required for this turn at the highest point is provided by his/her weight only. Then (g is the acceleration due to gravity)



(a) $v_0^2 - 2gh = \frac{1}{2}gR$
(b) $v_0^2 - 2gh = \frac{\sqrt{3}}{2}gR$

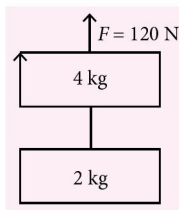
- (c) the centripetal force required at points x and z is zero
(d) the centripetal force required is maximum at points x and z

23. A bullet is fired from a gun. The force on the bullet is given by $F = 600 - 2 \times 10^5 t$ where F is in newton and t in second. The force on the bullet becomes zero as soon as it leaves the barrel. Then,

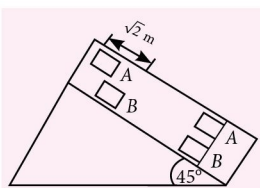
- (a) Impulse imparted to gun is 18 Ns.
(b) Average impulse imparted to bullet is 0.9 Ns
(c) The force is zero at 3 ms.
(d) The force is zero at 3 s.

Numerical Value Type

24. Two blocks of masses 2 kg and 4 kg are attached by an inextensible light string as shown in the figure. If a force of 120 N pulls the blocks vertically upward, the tension in the string is ____ N. (Take $g = 10 \text{ m/s}^2$)



25. Two blocks A and B of equal masses are placed on rough inclined plane as shown in figure. When will the two blocks come on the same line on the inclined plane if they are released simultaneously? Initially the block A is $\sqrt{2} \text{ m}$ behind the block B. Co-efficient of kinetic friction for the blocks A and B are 0.2 and 0.3 respectively ($g = 10 \text{ m/s}^2$).



26. When a body slides down from rest along a smooth inclined plane making an angle of 30° with the horizontal, it takes time T . When the same body slides down from the rest along a rough inclined plane making the same angle and through the same distance, it takes time αT , where α is a constant greater than 1. The co-efficient of friction between the body and the rough plane is $\frac{1}{\sqrt{x}} \left(\frac{\alpha^2 - 1}{\alpha^2} \right)$ where $x = \underline{\hspace{2cm}}$.

27. A solid horizontal surface is covered with a thin layer of oil. A rectangular block of mass $m = 0.4 \text{ kg}$ is at rest on this surface. An impulse of 1.0 Ns is applied to the block at time $t = 0$ so that it starts moving along the x -axis with a velocity $v(t) = v_0 e^{-t/\tau}$, where v_0 is a constant and $\tau = 4 \text{ s}$. The displacement of the block, in metres, at $t = \tau$ is _____. Take $e^{-1} = 0.37$.

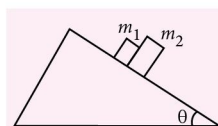
Comprehension Type

A projectile is thrown from a point O on the ground at an angle 45° from the vertical and with a speed $5\sqrt{2} \text{ m s}^{-1}$. The projectile at the highest point of its trajectory splits into two equal parts. One part falls vertically down to the ground, 0.5 s after the splitting. The other part, t seconds after the splitting, falls to the ground at a distance x meters from the point O. The acceleration due to gravity $g = 10 \text{ m s}^{-2}$.

28. The value of t is
(a) 0.3 s (b) 0.5 s (c) 0.2 s (d) 1 s
29. The value of x is
(a) 7.5 m (b) 8 m (c) 8.5 m (d) 0.7 m

Matrix Match Type

30. A block of mass $m_1 = 1 \text{ kg}$ another mass $m_2 = 2 \text{ kg}$, are placed together (see figure) on an inclined plane with angle of inclination θ . Various values of θ are given in List I. The coefficient of friction between the block m_1 and the plane is always zero. The coefficient of static and dynamic friction between the block m_2 and the plane are equal to $\mu = 0.3$. In List II expressions for the friction on block m_2 are given. Match the correct expression of the friction on List II with the angles given in List I, and choose the correct option. The acceleration due to gravity is denoted by g . [$\tan(5.5^\circ) \approx 0.1$; $\tan(11.5^\circ) \approx 0.2$; $\tan(16.5^\circ) \approx 0.2$]



List I		List II	
P.	$\theta = 5^\circ$	1.	$m_2 g \sin \theta$
Q.	$\theta = 10^\circ$	2.	$(m_1 + m_2) g \sin \theta$
R.	$\theta = 15^\circ$	3.	$\mu m_2 g \cos \theta$
S.	$\theta = 20^\circ$	4.	$\mu(m_1 + m_2) g \cos \theta$

- (a) P-1; Q-1; R-1; S-3 (b) P-2; Q-2; R-2; S-3
(c) P-2; Q-2; R-2; S-4 (d) P-2; Q-2; R-3; S-3



Keys are published in this issue. Search now! ☺

SELF CHECK

No. of questions attempted
No. of questions correct
Marks scored in percentage

Check your score! If your score is

> 90%	EXCELLENT WORK !	You are well prepared to take the challenge of final exam.
90-75%	GOOD WORK !	You can score good in the final exam.
74-60%	SATISFACTORY !	You need to score more next time
< 60%	NOT SATISFACTORY!	Revise thoroughly and strengthen your concepts.

BRUSH UP *for* NEET/JEE

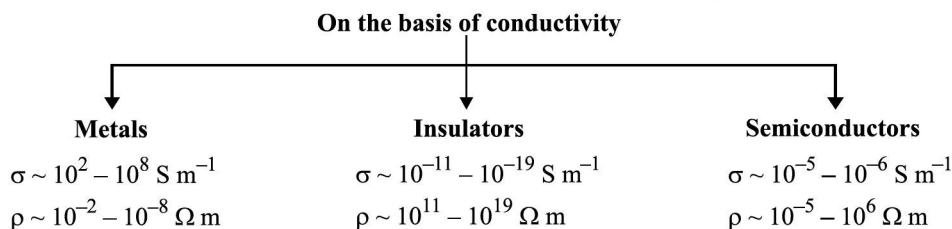
CLASS-XII

Brush up your concepts to get high rank in NEET/JEE (Main and Advanced) by reading this column. This specially designed column is updated year after year by a panel of highly qualified teaching experts well-tuned to the requirements of these Entrance Tests.

Unit 7

Semiconductor Electronics : Materials, Devices and Simple Circuits

CLASSIFICATION OF SOLIDS

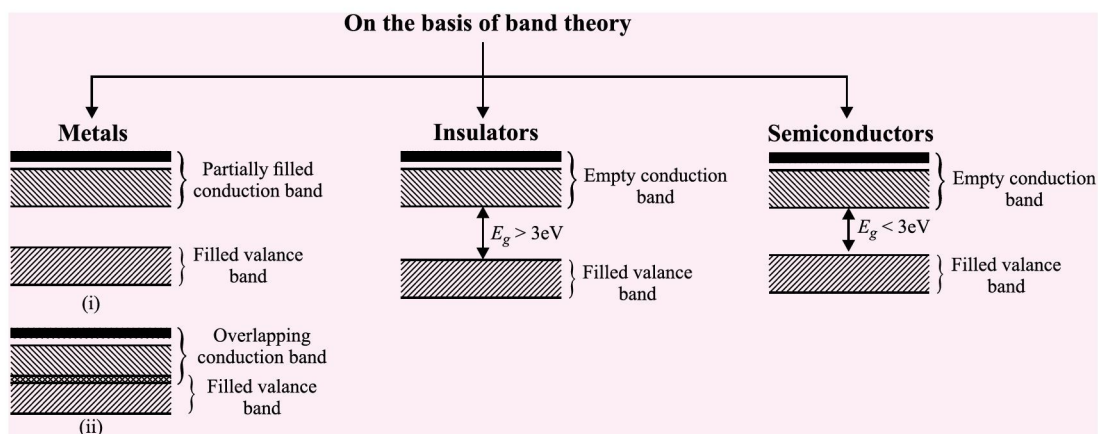


• Energy Bands in Solids :

Energy band : A group of large number of closely spaced energy levels.

Valance band : The highest energy band occupied by the valance electrons.

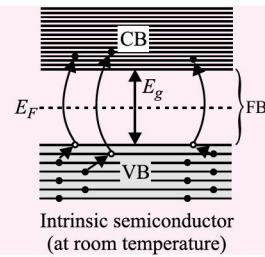
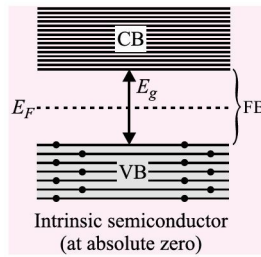
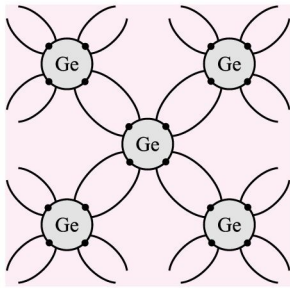
Conduction band : A lowest unoccupied or empty band next to the valance band.



- Band gap of Silicon and Germanium is 1.1eV and 0.7eV.

- **Intrinsic Semiconductors :** A semiconductor is free from impurities.

At any temperature $T > 0$, number of holes (n_h) = Number of electrons (n_e)

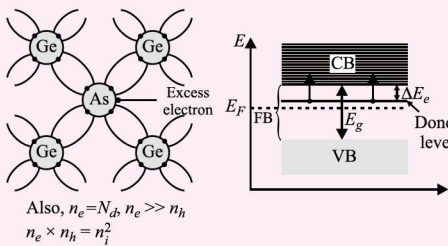


- Electron
- Hole

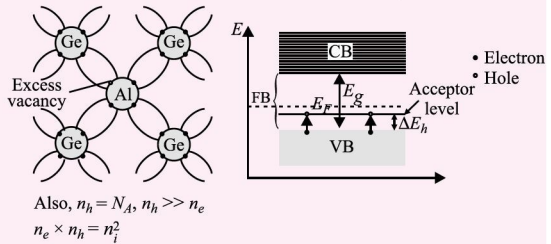
Extrinsic Semiconductor

(Semiconductor is doped with trivalent or pentavalent to increase conductivity)

n-type Semiconductor
(pentavalent impurity, P, As etc.)



p-type Semiconductor
(trivalent impurity, B, Al, In etc.)

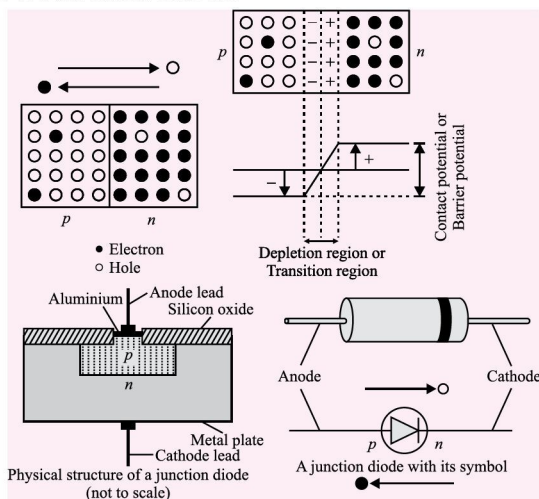


- Electron
- Hole

Electrical conductivity of semiconductor

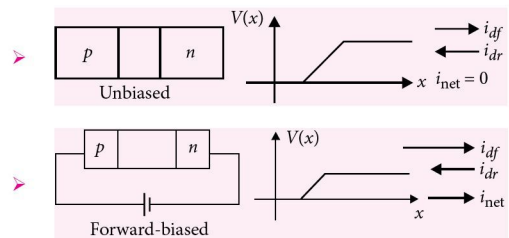
- Intrinsic semiconductor, $\sigma_i = en_i(\mu_e + \mu_h)$
($\because n_e = n_h = n_i$)
- n-type semiconductor, $\sigma_e \approx en_e \mu_e$ ($n_e \gg n_h$)
- p-type semiconductor, $\sigma_h \approx eh n_h \mu_h$ ($n_h \gg n_e$)

p-n Junction Diode

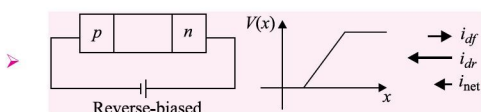


- **Diffusion current** : Because of high charge carrier concentration difference, hole diffuse from p-side to n-side ($p \rightarrow n$) and electron diffuse from n-side to p-side ($n \rightarrow p$), produces diffusion current.
- **Drift current** : Because of barrier potential, minority charge carriers are forced to move to other side of junction and such movement produce drift current.

- **Biasing of p-n junction**

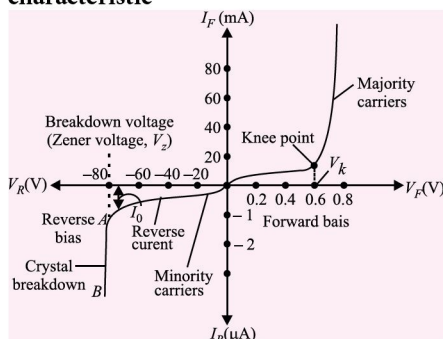


- Effective barrier potential decreases.
- Depletion width decreases.
- Low resistance offered at junction.
- High current flows through the circuit.



- Effective barrier potential increases.
- Depletion width increases.
- High resistance offered at junction.
- Low current flows through the circuit.

• I-V characteristic

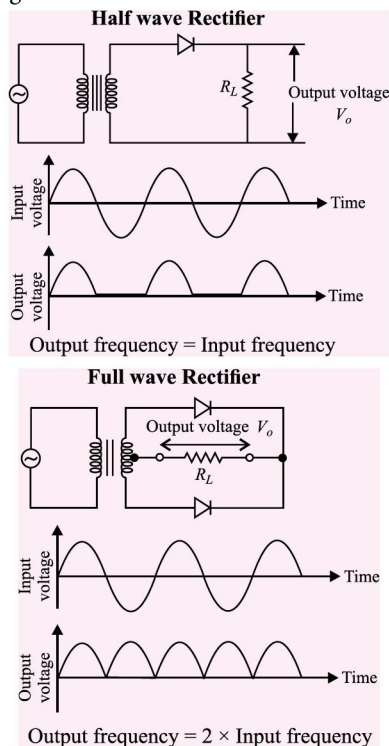


➤ Current flowing through the diode,

$$I = I_0 [e^{(eV/nkT)} - 1]; n = \text{constant} = \begin{cases} 1 & \text{for Ge} \\ 2 & \text{for Si} \end{cases}$$

- Dynamic resistance of p-n junction, $r_d = \frac{\Delta V}{\Delta I}$
- Static or dc resistance, $r_{dc} = V/I$

- **Diode as a rectifier :** Converts Ac voltage to Dc voltage.



UNSCRAMBLE ME

Unscramble the words given in column I and match them with their explanations in column II.

Column I

1. PECIONRIS
2. EROWP
3. AGNMEITTE
4. CEQELEUBR
5. REELKP
6. ACVNCOE
7. SELUNCU
8. ROSAN
9. ARHETGIN
10. TRUQOE

Column II

- (a) Instrument based on the reflection of ultrasonic waves.
- (b) Every atom consists of a tiny central core called
- (c) The rate of change of angular momentum.
- (d) The process of sharing charge with the earth.
- (e) It refers to the resolution or the limit to which the quantity is measured.
- (f) The S.I unit of radioactivity.
- (g) The dot product of force and velocity is called
- (h) Another name of lode stone.
- (i) Scientist who gave the laws of planetary motion.
- (j) Name a mirror which is used as a dentist mirror.

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month.
Winners' names and answers will be published in next issue.



WRAP it up!

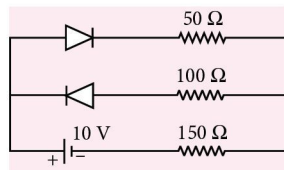
1. Given that the mobility of electrons in Ge is $0.4 \text{ m}^2 \text{ V}^{-1} \text{ s}^{-1}$ and electronic charge is $1.6 \times 10^{-19} \text{ C}$. The number of donor atoms per m^3 in semiconductor of conductivity 500 mho/m is

(a) 8×10^{21} (b) 8×10^{15}
(c) 5×10^{21} (d) 8×10^{16}

2. In an unbiased p - n junction, holes diffuse from the p -region to n -region because of

(a) the attraction of free electrons of n -region.
(b) the higher hole concentration in p -region than that in n -region.
(c) the higher concentration of electrons in the n -region than that in the p -region.
(d) the potential difference across the p - n junction.

3. Assume that each diode shown in the figure has a forward bias resistance of 50Ω and an infinite reverse bias resistance.



The current through the resistance 150Ω is

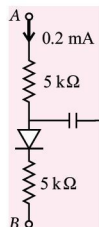
(a) 0.66 A (b) 0.05 A (c) zero (d) 0.04 A

4. Which one of the following represents forward bias diode?

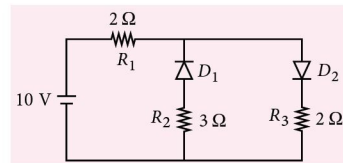
(a) -4 V R -3 V
(b) -2 V R $+2 \text{ V}$
(c) 3 V R 5 V
(d) 0 V R -2 V

5. In the circuit shown in figure, if the diode forward voltage is 0.3 V , the voltage difference between A and B is

(a) 1.3 V
(b) 2.3 V
(c) 0
(d) 0.5 V

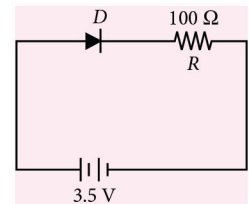


6. The given circuit has two ideal diodes connected as shown in the figure. The current flowing through the resistance R_1 will be



(a) 2.5 A (b) 10.0 A (c) 1.43 A (d) 3.13 A

7. In the given figure, a diode D is connected to an external resistance $R = 100 \Omega$ and an emf of 3.5 V . If the barrier potential developed across the diode is 0.5 V , the current in the circuit will be



(a) 20 mA (b) 35 mA (c) 30 mA (d) 40 mA

8. In the circuit shown assume the diode to be ideal. When V_i increases from 2 V to 6 V , the change in the current is (in mA)

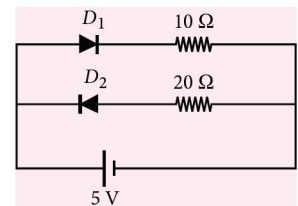


(a) zero (b) 20 (c) $80/3$ (d) 40

9. When plate voltage in diode valve is increased from 100 V to 150 V then plate current increases from 7.5 mA to 12 mA . The dynamic plate resistance will be

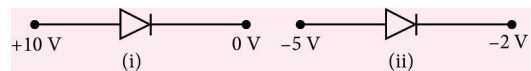
(a) $10 \text{ k}\Omega$ (b) $13 \text{ k}\Omega$
(c) $15 \text{ k}\Omega$ (d) $11.1 \text{ k}\Omega$

10. Two ideal diodes are connected to a battery as shown in the circuit. The current supplied by the battery is



(a) 0.75 A (b) zero (c) 0.25 A (d) 0.5 A

11. In the figures shown below.

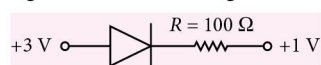


(a) In both figure (i) and figure (ii), the diodes are forward biased.
(b) In both figure (i) and figure (ii), the diodes are reverse biased.

- (c) In figure(i), the diode is forward biased and in figure(ii), the diode is reverse biased.
 (d) In figure(i), the diode is reverse biased and in figure(ii), the diode is forward biased.

12. The density of an electron-hole pair in a pure germanium is $3 \times 10^{16} \text{ m}^{-3}$ at room temperature. On doping with aluminium, the hole density increases to $4.5 \times 10^{22} \text{ m}^{-3}$. Now the electron density (in m^{-3}) in doped germanium will be
 (a) 1×10^{10} (b) 2×10^{10}
 (c) 0.5×10^{10} (d) 4×10^{10}

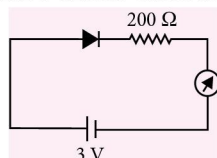
13. Assuming that the junction diode is ideal, the current in the arrangement shown in figure is



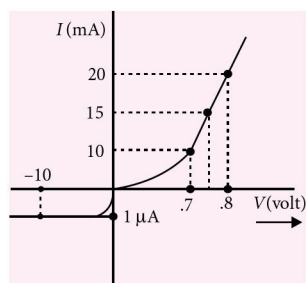
- (a) 30 mA (b) 40 mA (c) 20 mA (d) 10 mA

14. The reading of the ammeter for a silicon diode in the given circuit is

- (a) 0
 (b) 15 mA
 (c) 11.5 mA
 (d) 13.5 mA



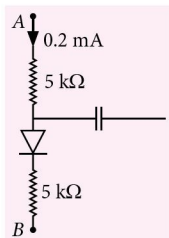
15. The V - I characteristic of a diode is shown in the figure. The ratio of forward to reverse bias resistance is



- (a) 100 (b) 10^6 (c) 10 (d) 10^{-6}

16. In the figure shown, if the diode forward voltage drop is 0.2 V, the voltage difference between A and B is

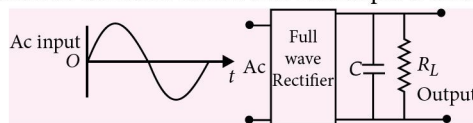
- (a) 1.3 V
 (b) 2.2 V
 (c) 0.5 V
 (d) 0



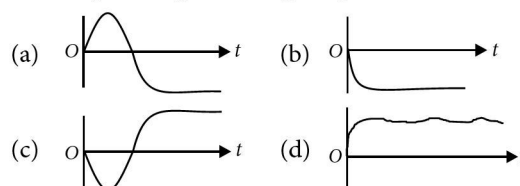
17. If the rms value of sinusoidal input to a full wave rectifier is $\frac{V_0}{\sqrt{2}}$ then the rms value of the rectifier's output is

- (a) $\frac{V_0}{\sqrt{2}}$ (b) $\frac{V_0^2}{\sqrt{2}}$ (c) $\frac{V_0^2}{2}$ (d) $\sqrt{2} V_0^2$

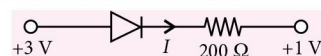
18. A full wave rectifier circuit with an ac input is shown.



The output voltage across R_L is represented as

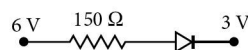


19. If an ideal junction diode is connected as shown, then the value of the current I is



- (a) 0.013 A (b) 0.02 A (c) 0.01 A (d) 0.1 A

20. The current through the ideal diode as shown in the figure is



- (a) 0 A (b) 0.02 A (c) 0.04 A (d) 0.06 A

SOLUTIONS

1. (a): Here, $\sigma = 500 \text{ mho/m}$,
 $e = 1.6 \times 10^{-19} \text{ C}$, $\mu_e = 0.4 \text{ m}^2 \text{ V}^{-1} \text{ s}^{-1}$

As $\sigma = n_e e \mu_e$

$$\therefore n_e = \frac{\sigma}{e \mu_e} = \frac{500}{1.6 \times 10^{-19} \times 0.4} = 7.8 \times 10^{21}$$

$$\approx 8 \times 10^{21} / \text{m}^3$$

The number of donor atoms is, $N_d \approx n_e = 8 \times 10^{21} / \text{m}^3$

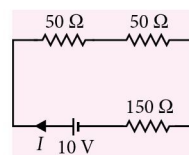
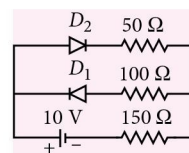
2. (b): In an unbiased p - n junction, holes diffuse from the p -region to n -region because of the higher hole concentration in p -region than that in n -region.

3. (d): In the circuit, diode D_1 is reverse biased and offers infinite resistance, diode D_2 is forward biased and offers 50Ω resistance. The equivalent circuit is shown in the figure.

Total resistance of the circuit,
 $R = 50 \Omega + 50 \Omega + 150 \Omega = 250 \Omega$
 The current in the circuit,

$$I = \frac{V}{R} = \frac{10 \text{ V}}{250 \Omega} = 0.04 \text{ A}$$

So, current through the resistance 150Ω is 0.04 A.



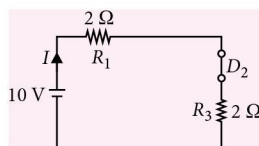
4. (d) : A diode is said to be forward biased if p -side is at higher potential than n -side of p - n junction.

5. (b) : Let V be the potential difference between A and B, then

$$V - 0.3 = (5 + 5) \times 10^3 \times (0.2 \times 10^{-3}) = 2$$

$$\text{or } V = 2 + 0.3 = 2.3 \text{ V}$$

6. (a) : Diode D_1 is reverse biased so, it will block the current and diode D_2 is forward biased so, it will pass the current.



Hence, equivalent circuit becomes as shown in the figure.

Current in the circuit = Current flowing through the resistance $R_1 = \frac{10}{2+2} = 2.5 \text{ A}$

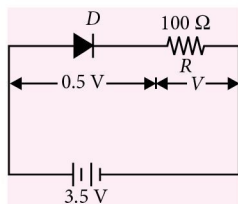
7. (c) : The potential difference across the resistance R is

$$V = 3.5 \text{ V} - 0.5 \text{ V} = 3 \text{ V}$$

By Ohm's law, the current in the circuit is

$$I = \frac{V}{R} = \frac{3 \text{ V}}{100 \Omega} = 3 \times 10^{-2} \text{ A}$$

$$= 30 \times 10^{-3} \text{ A} = 30 \text{ mA}$$



8. (b) : V_i 150 Ω $+3 \text{ V}$

As the diode is ideal, it offers zero resistance when forward biased and offers infinite resistance when reverse biased.

When $V_i = 2 \text{ V}$, the diode gets reverse biased and offers infinite resistance. Hence, no current flows in it.

i.e. $I_{\text{initial}} = 0 \text{ A}$

When $V_i = 6 \text{ V}$, the diode gets forward biased and offers zero resistance.

$$\therefore I_{\text{final}} = \frac{6 \text{ V} - 3 \text{ V}}{150 \Omega} = \frac{3}{150} \text{ A} = 0.02 \text{ A}$$

$$\therefore \text{Change in current, } \Delta I = I_{\text{final}} - I_{\text{initial}} = 0.02 \text{ A} - 0 \text{ A} = 0.02 \text{ A} = 20 \text{ mA}$$

$$9. (d) : r_p = \frac{\Delta V_p}{\Delta I_p} = \frac{150 - 100}{(12 - 7.5) \times 10^{-3}} = 11.1 \text{ k}\Omega$$

10. (d) : In the given circuit, the upper diode D_1 is forward biased and the lower diode D_2 is reverse biased. Therefore the resistance of D_1 is zero and that of D_2 is infinite. So, the current supplied by the battery is

$$I = \frac{5 \text{ V}}{10 \Omega} = \frac{1}{2} \text{ A} = 0.5 \text{ A}$$

11. (c) : In figure (i), the diode is forward biased as p is at a higher potential (10 V) than n (0 V).

In figure (ii), the diode is reverse biased as p is at a lower potential (−5 V) than n (−2 V).

12. (b) : In pure germanium,

$$n_i = n_e = n_h = 3 \times 10^{16} \text{ m}^{-3}$$

In doped germanium, $n_i^2 = n_e n_h$

$$\therefore n_e = \frac{n_i^2}{n_h} = \frac{(3 \times 10^{16} \text{ m}^{-3})^2}{4.5 \times 10^{22} \text{ m}^{-3}} = \frac{9 \times 10^{32}}{4.5 \times 10^{22}} \text{ m}^{-3} = 2 \times 10^{10} \text{ m}^{-3}$$

Thus, the electron density in doped germanium will be $2 \times 10^{10} \text{ m}^{-3}$.

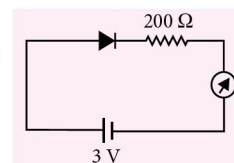
13. (c) : $+3 \text{ V}$ 100Ω $+1 \text{ V}$

In the given circuit the junction diode is forward biased and offers zero resistance.

$$\text{Current, } I = \frac{3 \text{ V} - 1 \text{ V}}{100 \Omega} = 0.02 \text{ A} = 20 \text{ mA}$$

14. (c) : Current in the circuit,

$$I = \frac{V - V_{\text{diode}}}{R} = \frac{3 - 0.7}{200} = \frac{2.3}{200} \text{ A} = \frac{2300}{200} \text{ mA} = 11.5 \text{ mA}$$



15. (d) : Forward bias resistance,

$$R_1 = \frac{\Delta V}{\Delta I_{\text{for}}} = \frac{0.8 - 0.7}{(20 - 10) \times 10^{-3}} = \frac{0.1}{10 \times 10^{-3}} = 10$$

$$\text{Reverse bias resistance, } R_2 = \frac{10}{1 \times 10^{-6}} = 10^7$$

then, the ratio of forward to reverse bias resistance,

$$\frac{R_1}{R_2} = \frac{10}{10^7} = 10^{-6}$$

16. (b) : Using Kirchhoff's law

$$V_{AB} = 2(0.2 \text{ mA} \times 5 \text{ k}\Omega) + (0.2 \text{ V}) = 2.2 \text{ V}$$

17. (a) : The rms value of the output voltage at the load

$$\text{resistance, } V_{\text{rms}} = \frac{V_0}{\sqrt{2}}$$

18. (d)

19. (c) : In the given circuit the junction diode is forward biased and offers zero resistance.

$$\therefore \text{The current, } I = \frac{3 \text{ V} - 1 \text{ V}}{200 \Omega} = \frac{2 \text{ V}}{200 \Omega} = 0.01 \text{ A}$$

20. (b) : Here, the diode is forward biased.

$$\therefore \text{The current through the diode, } I = \frac{6 \text{ V} - 3 \text{ V}}{150 \Omega} = 0.02 \text{ A}$$



CBSE warm-up!

Exam on
6th March
2023

CLASS-XII

Practice questions for CBSE Exams as per the latest pattern
and reduced syllabus by CBSE for the academic session 2022-23.

Practice Paper 2022-23

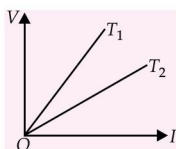
Time Allowed : 3 hours
Maximum Marks : 70

General Instructions :

- There are 35 questions in all. All questions are compulsory.
- This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.
- Section A contains eighteen MCQ of 1 mark each, Section B contains seven questions of two marks each, Section C contains five questions of three marks each, section D contains three long questions of five marks each and Section E contains two case study based questions of 4 marks each.
- There is no overall choice. However, an internal choice has been provided in section B, C, D and E. You have to attempt only one of the choices in such questions.
- Use of calculators is not allowed.

SECTION - A

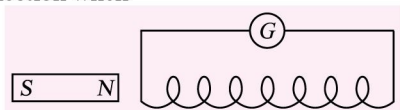
- When two bodies are rubbed against each other, they acquire
 - equal and similar charges
 - equal and opposite charges
 - unequal and similar charges
 - unequal and opposite charges.
- Consider a uniform electric field in the z -direction. The potential is a constant
 - for any x for a given z
 - for any y for a given z
 - on the x - y plane for a given z
 - all of these.
- The voltage V and current I graphs for a conductor at two different temperatures T_1 and T_2 are shown in the figure. The relation between T_1 and T_2 is



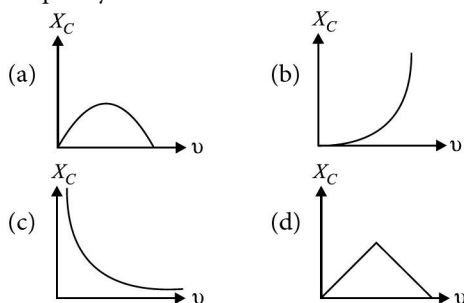
- $T_1 > T_2$
 - $T_1 < T_2$
 - $T_1 = T_2$
 - $T_1 = 1/T_2$
- If the current sensitivity of a galvanometer is doubled, then its voltage sensitivity will be
 - doubled
 - halved
 - unchanged
 - four times
 - Two parallel wires 2 m apart carry currents of 2 A and 5 A respectively in same direction, the force per unit length acting between these two wires is
 - $2 \times 10^{-6} \text{ N m}^{-1}$
 - $3 \times 10^{-6} \text{ N m}^{-1}$
 - $1 \times 10^{-6} \text{ N m}^{-1}$
 - $4 \times 10^{-6} \text{ N m}^{-1}$
 - Which of the following is not correct about the magnetic field lines?
 - The magnetic field lines of a magnet form continuous closed loops.
 - The tangent to the field line at a given point represents the direction of the net magnetic field B at that point.

- (c) The larger the number of field lines crossing per unit area, the stronger is the magnitude of the magnetic field B .
 (d) The magnetic field lines may intersect to each other in certain conditions.

7. In the figure, galvanometer G gives maximum deflection when



- (a) magnet is pushed into the coil
 (b) magnet is rotated into the coil
 (c) magnet is stationary at the centre of the coil
 (d) number of turns in the coil is reduced.
8. Which of the following statements is false for the properties of electromagnetic waves?
 (a) Both electric and magnetic field vectors attain the maxima and minima at the same place and same time.
 (b) The energy in electromagnetic wave is divided equally between electric and magnetic field vectors.
 (c) Both electric and magnetic field vectors are parallel to each other and perpendicular to the direction of propagation of wave.
 (d) These waves do not require any material medium for propagation.
9. Which of the following graphs represents the correct variation of capacitive reactance X_C with frequency ν ?



10. In Young's double slit experiment the ratio of intensity of the maxima and minima in the interference experiment is 25 : 9. The ratio of widths of two slits is
 (a) 18 : 3 (b) 4 : 1 (c) 8 : 1 (d) 16 : 1
11. The work function for Al, K and Pt is 4.28 eV, 2.30 eV and 5.65 eV respectively. Their respective threshold frequencies would be

- (a) $Pt > Al > K$ (b) $Al > Pt > K$
 (c) $K > Al > Pt$ (d) $Al > K > Pt$

12. The radius of electron orbit and the speed of electron in the ground state of hydrogen atom is $5.30 \times 10^{-11} \text{ m}$ and $2.2 \times 10^6 \text{ m s}^{-1}$ respectively, then the orbital period of this electron in first excited state will be

- (a) $1.21 \times 10^{-14} \text{ s}$ (b) $1.21 \times 10^{-12} \text{ s}$
 (c) $1.21 \times 10^{-10} \text{ s}$ (d) $1.21 \times 10^{-15} \text{ s}$

13. Two nuclei have their mass numbers in the ratio of 1 : 3. The ratio of their nuclear densities would be

- (a) $(3)^{1/3} : 1$ (b) 1 : 1
 (c) 1 : 3 (d) 3 : 1

14. A capacitor of capacity $0.5 \mu\text{F}$ is discharged through a resistance of 10 mega ohm. The time taken for half the charge on the capacitor to escape is (take $\log_e 2 = 0.6931$)

- (a) 3.46 s (b) 4.88 s
 (c) 2.12 s (d) 5.65 s

15. A bar magnet of pole strength 10 A m is cut into two equal parts breadthwise. The pole strength of each magnet is

- (a) 5 A m (b) 10 A m
 (c) 15 A m (d) 20 A m

For question numbers 16-18, two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

- (a) Both A and R are true and R is the correct explanation of A.
 (b) Both A and R are true but R is NOT the correct explanation of A.
 (c) A is true but R is false.
 (d) A is false and R is also false.

16. **Assertion:** When a plane wave passes through a thin prism, the emerging wave front gets tilted.

Reason: Speed of light is less in glass than in air.

17. **Assertion:** All the photoelectrons emitted from the metal do not have the same energy.

Reason: The maximum kinetic energy of photoelectrons depends on the light source and the emitter plate material.

18. **Assertion:** The conductivity of an intrinsic semiconductor depends on its temperature.

Reason: The conductivity of an intrinsic semiconductor is slightly higher than that of a lightly doped p -type semiconductor.

SECTION - B

19. Arrange the following electromagnetic radiations in ascending order of their frequencies:

- Microwave
- Radiowave
- X-rays
- Gamma rays

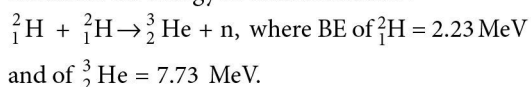
Write two uses of any one of these.

20. Draw magnetic field lines when a

- diamagnetic,
- paramagnetic substance is placed in an external magnetic field.

Which magnetic property distinguishes this behaviour of the field lines due to the two substances?

21. Calculate the energy in fusion reaction :



OR

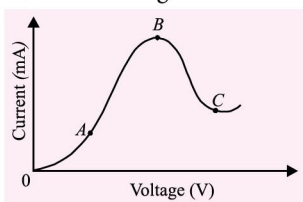
Show that the radius of the orbit in hydrogen atom varies as n^2 , where n is the principle quantum number of the atom.

22. Draw a ray diagram of an astronomical telescope in the normal adjustment position. State two drawbacks of this type of telescope.

23. What happens to the width of depletion layer of a p - n junction when it is (i) forward biased, (ii) reverse biased ?

OR

The graph shown in the figure represents a plot of current versus voltage for a given semiconductor. Identify the region, if any, over which the semiconductor has a negative resistance.



24. State one feature by which the phenomenon of interference can be distinguished from that of diffraction.

A parallel beam of light of wavelength 600 nm is incident normally on a slit of width ' a '. If the distance between the slits and the screen is 0.8 m and the distance of 2nd order maximum from the centre of the screen is 15 mm, calculate the width of the slit.

25. Given a uniform electric field $\vec{E} = 2 \times 10^3 \hat{i}$ N/C, find the flux of this field through a square of side 20 cm, whose plane is parallel to the y - z plane. What would be the flux through the same square, if the plane makes an angle of 30° with the x -axis?

SECTION - C

26. An ammeter of resistance 0.80Ω can measure current upto 1.0 A.

- What must be the value of shunt resistance to enable the ammeter to measure current upto 5.0 A?
- What is the combined resistance of the ammeter and the shunt?

27. (a) Define self inductance. Write its S.I. units.

(b) Derive an expression for self inductance of a long solenoid of length l , cross-sectional area A having N number of turns

28. Describe briefly, with the help of a labelled diagram, the basic elements of an a.c. generator. State its underlying principle. Show diagrammatically how an alternating emf is generated by a loop of wire rotating in a magnetic field. Write the expression for the instantaneous value of the emf induced in the rotating loop.

OR

(a) Prove that an ideal capacitor in an ac circuit does not dissipate power.

(b) An inductor of 200 mH, capacitor of 400 μF and a resistor of 10Ω are connected in series to ac source of 50 V of variable frequency. Calculate the (i) angular frequency at which maximum power dissipation occurs in the circuit and the corresponding value of the effective current, and (ii) value of Q-factor in the circuit.

29. A proton and an α -particle have the same De-broglie wavelength. Determine the ratio of

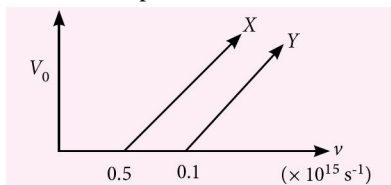
- their accelerating potentials.
- their speeds.

MONTHLY TEST DRIVE CLASS XII ANSWER KEY

- | | | | | |
|------------|------------|------------|------------------|---------|
| 1. (b) | 2. (d) | 3. (a) | 4. (c) | 5. (c) |
| 6. (a) | 7. (a) | 8. (c) | 9. (b) | 10. (b) |
| 11. (d) | 12. (a) | 13. (b) | 14. (c) | 15. (a) |
| 16. (b) | 17. (a) | 18. (c) | 19. (a, c, d) | |
| 20. (c, d) | 21. (a, c) | 22. (b, c) | 23. (a, b, c, d) | |
| 24. (3840) | 25. (11.5) | 26. (1.33) | 27. (8) | 28. (c) |
| 29. (a) | 30. (b) | | | |

OR

The following graph shows the variation of stopping potential V_0 with the frequency ν of the incident radiation for two photosensitive metals X and Y :

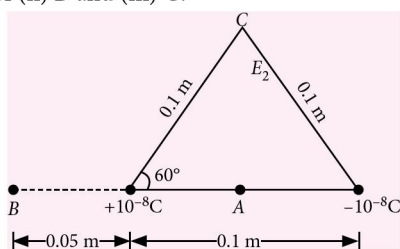


- Which of the metals has larger threshold wavelength? Give reason.
- Explain, giving reason, which metal gives out electrons, having larger kinetic energy, for the same wavelength of the incident radiation.
- If the distance between the light source and metal X is halved, how will the kinetic energy of electrons emitted from it change? Give reason.

30. Write two important limitations of Rutherford model which could not explain the observed features of atomic spectra. How were these explained in Bohr's model of hydrogen atom? Use the Rydberg formula to calculate the wavelength of the H_α line. (Take $R = 1.1 \times 10^7 \text{ m}^{-1}$).

SECTION - D

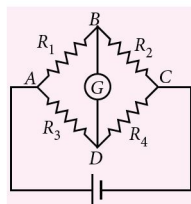
31. Two point charges $+10^{-8} \text{ C}$ and -10^{-8} C are placed 0.1 m apart. Calculate the electric fields at points (i) A (ii) B and (iii) C.



OR

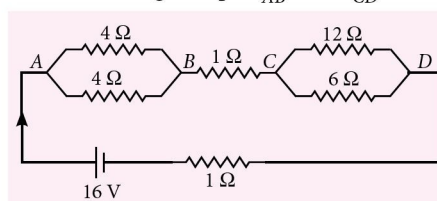
Derive an expression for the potential energy of an electric dipole in a uniform electric field. Explain conditions for stable and unstable equilibrium.

32. The given figure shows a network of resistance R_1 , R_2 , R_3 and R_4 . Using Kirchhoff's laws establish the balance condition for the network.



OR

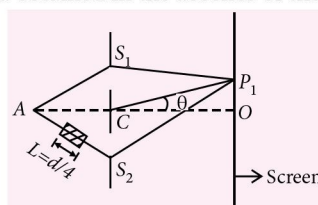
A network of resistors is connected to a 16 V battery of internal resistance of 1Ω as shown in the figure. Obtain the voltage drops V_{AB} and V_{CD} .



- What do you mean by dispersion?
- Explain the cause of dispersion.

OR

A small transparent slab containing material of $\mu = 1.5$ is placed along AS_2 (figure). What will be the distance from O of the principal maxima and of the first minima on either side of the principal maxima obtained in the absence of the glass slab.



$$AC = CO = D, S_1C = S_2C = d \ll D$$

SECTION - E

34. Read the following paragraph and answer the questions.

Case Study : The lens maker's formula relates the focal length of a lens to the refractive index of the lens material and the radii of curvature of its two surfaces. This formula is called so because it is used by manufacturers to design lenses of required focal length from a glass of given refractive index.

If the object is placed at infinity, the image will be formed at focus for both double convex lens and double concave lens. Therefore, lens maker's

formula is,
$$\frac{1}{f} = \left[\frac{\mu_2 - \mu_1}{\mu_1} \right] \left[\frac{1}{R_1} - \frac{1}{R_2} \right]$$

Motivational Quote

"Punctuality is not about being on time, It is basically about respecting your own commitments".

When lens is placed in air, $\mu_1 = 1$ and $\mu_2 = \mu$. The lens maker formula takes the form,

$$\frac{1}{f} = (\mu - 1) \left[\frac{1}{R_1} - \frac{1}{R_2} \right]$$

(i) The radii of curvature of the faces of a double convex lens are 10 cm and 15 cm. If focal length is 12 cm, then find refractive index of glass.

(ii) Why an under-water swimmer cannot see very clearly even in absolutely clear water?

(iii) A thin lens of glass ($\mu = 1.5$) of focal length 10 cm is immersed in water ($\mu = 1.33$). Find the new focal length.

OR

The radius of curvature of each face of biconcave lens with refractive index 1.5 is 30 cm. Find the focal length of the lens in air.

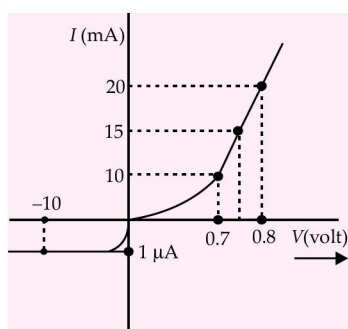
35. Read the following paragraph and answer the questions.

Case Study : When the diode is forward biased, it is found that beyond forward voltage $V = V_k$ called knee voltage, the conductivity is very high. At this value of battery biasing for p - n junction, the potential barrier is overcome and the current increases rapidly with increase in forward voltage. When the diode is reverse biased, the reverse bias voltage produces a very small current about a few microamperes which almost remains constant with bias. This small current is reverse saturation current.

(i) What are non-ohmic device? Give examples.

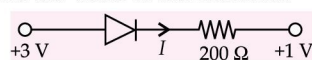
(ii) Draw the diagrams of forward biasing of a p - n junction diode and correctly depicts the direction of conventional current.

(iii) The V - I characteristic of a diode is shown in the figure. The ratio of forward to reverse bias resistance is



OR

If an ideal junction diode is connected as shown, determine the value of the current I .



SOLUTIONS

- | | | | |
|---------|---------|---------|---------|
| 1. (b) | 2. (d) | 3. (a) | 4. (c) |
| 5. (c) | 6. (d) | 7. (a) | 8. (c) |
| 9. (c) | 10. (d) | 11. (a) | 12. (d) |
| 13. (b) | 14. (a) | 15. (b) | 16. (a) |
| 17. (b) | 18. (c) | | |

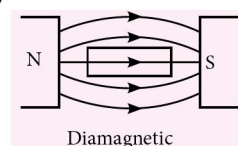
19. In ascending order of their frequencies :

Radiowave < Microwave < X-rays < Gamma rays.

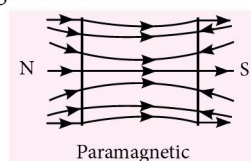
Two uses of microwaves are :

1. In microwave ovens.
2. In aircraft navigation.

20. (i) When a diamagnetic material is placed in an external magnetic field.



(ii) When a paramagnetic material is placed in an external magnetic field.



Magnetic susceptibility distinguishes this behavior of the field lines due to the two substances.

21. Total binding energy of initial system (E_i)
 $= {}^2_1\text{H} + {}^2_1\text{H} = (2.23 + 2.23) \text{ MeV} = 4.46 \text{ MeV}$
 Binding energy of final system
 i.e. ${}^3_2\text{He}(E_f) = 7.73 \text{ MeV}$
 Hence, energy released, $\Delta E = E_f - E_i$
 $= 7.73 \text{ MeV} - 4.46 \text{ MeV} = 3.27 \text{ MeV}$

OR

When an electron moves around hydrogen nucleus, the electrostatic force between electron and hydrogen nucleus provides necessary centripetal force.

$$\frac{mv^2}{r} = \frac{1}{4\pi\epsilon_0} \frac{e^2}{r^2} \quad \text{or} \quad mv^2r = \frac{n^2h^2}{4\pi^2} \quad \dots(i)$$

Also we know from Bohr's postulate,

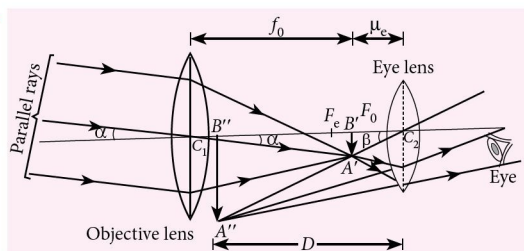
$$mvr = \frac{nh}{2\pi} \quad \text{or} \quad m^2 v^2 r^2 = \frac{n^2 h^2}{4\pi^2} \quad \dots(ii)$$

Dividing (ii) by (i), we have

$$mr = \frac{n^2 h^2}{4\pi^2} \times \frac{4\pi \epsilon_0}{e^2}$$

$$\therefore r = \frac{n^2 h^2}{4\pi^2 m e^2} \cdot 4\pi \epsilon_0 \therefore r \propto n^2$$

22.



Drawbacks :

- Images formed by these telescopes have chromatic aberrations.
- Lesser resolving power.
- The image formed is inverted and fainter.

23. Forward biased : As forward voltage opposes the potential barrier and effective barrier potential decreases. It makes the width of the depletion layer smaller.

(ii) Reverse biased : As reverse voltage supports the potential barrier and effective barrier potential increases. It makes the width of the depletion layer larger.

OR

Region BC of the graph has a negative slope, hence in region BC semiconductor has a negative resistance.

24. (i) In interference all the maxima are of equal intensity. In diffraction pattern central fringe is of maximum intensity while intensity of secondary maxima falls rapidly.

(ii) Given : $\lambda = 600 \text{ nm} = 6 \times 10^{-7} \text{ m}$,

$D = 0.8 \text{ m}$, $\beta_2 = 15 \times 10^{-3} \text{ m}$

To calculate : Width of the slit 'd'

$$\text{Calculation : } \beta_2 = \frac{5}{2} \times \frac{\lambda D}{d} \Rightarrow d = \frac{5}{2} \times \frac{6 \times 10^{-7} \times 0.8}{15 \times 10^{-3}}$$

$\therefore$ Distance, $d = 8 \times 10^{-5} = 80 \mu\text{m}$

25. Given : $\vec{E} = 5 \times 10^3 \hat{i} \text{ N/C}$

$A = 10 \times 10 \times 10^{-4} \text{ m}^2$, Flux (ϕ) = $EA \cos \theta$

(i) For first case, $\theta = 0$, $\cos 0^\circ = 1$

$\therefore$ Flux = $(5 \times 10^3) \times (10 \times 10 \times 10^{-4}) = 50 \text{ Nm}^2\text{C}^{-1}$

(ii) Angle of square plane with x-axis = 30°

Hence θ will be $90^\circ - 30^\circ = 60^\circ$

Flux(ϕ) = $EA \cos \theta^\circ$

= $(5 \times 10^3) \times (10 \times 10 \times 10^{-4}) \times \cos 60^\circ$

= $50 \times 0.5 = 25 \text{ Nm}^2\text{C}^{-1}$

26. (i) $R_g = 0.80 \Omega$, $i_g = 1.0 \text{ A}$, $i = 5 \text{ A}$

$$\text{Shunt, } S = \left(\frac{i_g}{i - i_g} \right) R_g = \left(\frac{1}{5 - 1} \right) 0.80 = \frac{1}{4} \times 0.80 = 0.20 \Omega$$

(ii) Combined resistance of ammeter and shunt,

$$\frac{1}{R_{\text{combined}}} = \frac{1}{R_g} + \frac{1}{S} = \frac{1}{0.80} + \frac{1}{0.20}$$

$$= \frac{1 + 4}{0.80} = \frac{5}{0.80} = \frac{50}{8}$$

$$\therefore R_{\text{combined}} = \frac{8}{50} = 0.16 \Omega$$

27. (a) Self-inductance of a coil

Since, flux $\phi = LI$, emf induced $\epsilon = -\frac{d\phi}{dt} = -L \frac{di}{dt}$

where, L is coefficient of self-induction or self inductance.

Self inductance is numerically equal to the magnetic flux linked with the coil when unit current passes through it. Its S.I. unit is Henry.

(b) Consider a long solenoid of length l and radius r with $r \ll l$ and having n turns per unit length. If a current I flows through the coil, then the magnetic field inside the coil is almost constant and is given by $B = \mu_0 nI$

Magnetic flux linked with each turn = $BA = \mu_0 nIA$ where $A = \pi r^2$ = cross-sectional area of the solenoid.

$\therefore$ Magnetic flux linked with the entire solenoid is ϕ = Flux linked with each turn $\times$ Total number of turns



EXAM ALERT 2023

Exam	Date
JEE Main Session 2	6 th , 8 th , 10 th , 11 th and 12 th April
WB JEE	30 th April
NEET	7 th May
CUET	21 st to 31 st May
MHT CET PCM	9 th to 13 th May
MHT CET PCB	15 th to 20 th May
BITSAT	Session - 1 : 22 nd to 26 th May
	Session - 2 : 18 th to 22 nd June
JEE Advanced	4 th June

$$\phi = \mu_0 n I A \times n l = \mu_0 n^2 I A l$$

$$\text{But } \phi = L I$$

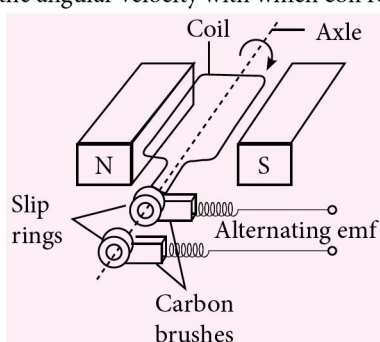
$\therefore$ Self-inductance of the long solenoid is

$$L = \mu_0 n^2 I A$$

If N is the total number of turns in the solenoid

$$\text{then } n = \frac{N}{l} \therefore L = \frac{\mu_0 N^2 A}{l}$$

- 28.** Let N = number of turns in the coil
 A = Area of face of each turn
 B = magnitude of the magnetic field
 θ = angle which normal to the coil makes with field B at any instant
 ω = the angular velocity with which coil rotates



The magnetic flux linked with the coil at any instant t will be,

$$\phi = NAB \cos \theta = NAB \cos \omega t$$

By Faraday's flux rule, the induced emf is given by,

$$E = -\frac{d\phi}{dt} = \frac{d}{dt} NAB(\cos \omega t)$$

$$E = NAB(\sin \omega t) \cdot \omega$$

$$\Rightarrow E = E_0 \sin \omega t, \text{ where } [E_0 = NAB\omega]$$

When a load of resistance R is connected across the terminals, a current I flows in the external circuit.

$$I = \frac{E}{R} = \frac{E_0 \sin \omega t}{R} = I_0 \sin \omega t, \text{ where } \left[I_0 = \frac{E_0}{R} \right]$$

OR

(a) Power dissipated in AC circuit is given by

$$P = V_{\text{rms}} I_{\text{rms}} \cos \phi, \text{ where } \cos \phi = \frac{R}{Z}$$

$$\text{For an ideal capacitor, } R = 0, \cos \phi = \frac{R}{Z} = 0$$

$$P = V_{\text{rms}} I_{\text{rms}} \times (0) = 0$$

i.e., power dissipated in an ideal capacitor is zero.

(b) Given : $L = 200 \text{ mH}$, $C = 400 \mu\text{F}$,

$$R = 10 \Omega, V = 50 \text{ V}$$

$$(i) \text{ angular frequency } (\omega_0) = \frac{1}{\sqrt{LC}}$$

$$= \frac{1}{\sqrt{(200 \times 10^{-3}) \times (400 \times 10^{-6})}}$$

$$= \frac{1}{\sqrt{8 \times 10^{-5}}} = \frac{10^3}{\sqrt{80}} = \frac{1000}{8.9} = 112 \text{ rad/s}$$

Corresponding value of current (I)

$$= \frac{V}{R} = \frac{50}{10} = 5 \text{ A}$$

$$(ii) \text{ Q factor} = \frac{1}{R} \sqrt{\frac{L}{C}} = \frac{1}{10} \sqrt{\frac{(200 \times 10^{-3})}{(400 \times 10^{-6})}} = \sqrt{5}$$

29. The de-Broglie wavelength for a proton is,

$$\lambda_1 = \frac{h}{2m_1 q_1 V_1} \text{ and for } \alpha\text{-particle } \lambda_2 = \frac{h}{2m_2 q_2 V_2}$$

$$\text{Given } \lambda_1 = \lambda_2, \frac{h}{2m_1 q_1 V_1} = \frac{h}{2m_2 q_2 V_2}$$

$$(i) \frac{V_1}{V_2} = \frac{m_2 q_2}{m_1 q_1}$$

We know, $m_2 = 4m_1$ and $q_2 = 2q_1$

$$\frac{V_1}{V_2} = \frac{4m_1 \times 2q_1}{m_1 q_1} = 8; V_1 : V_2 = 8 : 1$$

$$(ii) \lambda_1 = \frac{h}{m_1 v_1} \text{ and } \lambda_2 = \frac{h}{m_2 v_2}$$

$$\text{As, } \lambda_1 = \lambda_2$$

$$\frac{h}{m_1 v_1} = \frac{h}{m_2 v_2}; \quad \frac{v_1}{v_2} = \frac{m_2}{m_1} = \frac{4m_1}{m_1} = 4$$

$$v_1 : v_2 = 4 : 1$$

OR

$$(i) \lambda = \frac{c}{\nu}$$

$$\text{As } (\nu_0)_X < (\nu_0)_Y \therefore (\lambda_0)_X > (\lambda_0)_Y$$

$\therefore$ Metal 'X' has larger threshold wavelength

(ii) According to Einstein's photoelectric equation:

$$\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + K.E. \text{ of photoelectric}$$

For the same λ of incident radiation, L.H.S. is constant. So metal X with higher value of λ_0 will emit photoelectrons of larger K.E.

(iii) Kinetic energy will not change. On reducing the distance only intensity of light changes, frequency remains same. K.E. of emitted photoelectrons depends on frequency.

30. Limitations of Rutherford Model :

(i) Electrons moving in a circular orbit around the nucleus would get, accelerated, therefore it would spiral into the nucleus, as it loses its energy.

(ii) It must emit a continuous spectrum.

Explanation according to Bohr's model of hydrogen atom :

(i) Electron in an atom can revolve in certain stable orbits without the emission of radiant energy.

(ii) Energy is released/absorbed only, when an electron jumps from one stable orbit to another stable orbit. This results in a discrete spectrum.

Wavelength of H_α line :

H_α line is formed when an electron jumps from $n_f = 3$ to $n_i = 2$ orbit. It is the Balmer series

$$\frac{1}{\lambda} = R \left(\frac{1}{2^2} - \frac{1}{3^2} \right); \frac{1}{\lambda} = (1.1 \times 10^7) \left(\frac{1}{4} - \frac{1}{9} \right)$$

$$\text{or } \lambda \approx 655 \text{ nm}$$

31. Refer to answer 31, Page no. 32-33, Class-12, MTG 100 percent Physics.

OR

Refer to answer 18, Page no. 77, Class-12, MTG 100 percent Physics.

32. Refer to answer 27, Page no. 148, Class-12, MTG 100 percent Physics.

OR

Refer to answer 15, Page no. 135, Class-12, MTG 100 percent Physics.

33. (a) Refer to answer 15, Page no. 418, Class-12, MTG 100 percent Physics.

(b) Refer to answer 16, Page no. 418-419, Class-12, MTG 100 percent Physics.

OR

Refer to answer 20, Page no. 468, Class-12, MTG 100 percent Physics.

34. (i) Here, $f = 12 \text{ cm}$; $R_1 = 10 \text{ cm}$; $R_2 = -15 \text{ cm}$

$$\text{As } \frac{1}{f} = (\mu - 1) \left[\frac{1}{R_1} - \frac{1}{R_2} \right]; \frac{1}{12} = (\mu - 1) \left[\frac{1}{10} + \frac{1}{15} \right]$$

$$\mu = 1.5$$

(ii) The eye-lens is surrounded by a different medium than air. This will change the focal length of the eye-lens. The eye cannot accommodate all images as it would do in air.

$$(iii) \frac{1}{f} = (1.5 - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

$$\text{and } \frac{1}{f_w} = \left(\frac{1.5}{1.33} - 1 \right) \left(\frac{1}{R_1} - \frac{1}{R_2} \right); \frac{f_w}{f} = \frac{0.5 \times 1.33}{0.17} = 4$$

$$f_w = 4f = 4 \times 10 = 40 \text{ cm}$$

OR

Here, $\mu = 1.5$; $R_1 = 30 \text{ cm}$; $R_2 = -30 \text{ cm}$

$$\text{As } \frac{1}{f} = (\mu - 1) \left[\frac{1}{R_1} - \frac{1}{R_2} \right]$$

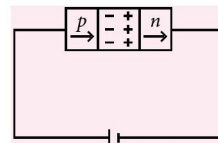
$$\text{After taking sign. convention} = -(1.5 - 1) \left[\frac{1}{30} + \frac{1}{30} \right]$$

$$= -0.5 \times \frac{2}{30} = \frac{-1}{30}; f = -30 \text{ cm}$$

35. (i) Non-ohmic devices are those devices which do not obey the Ohm's law. For example, Diode, vacuum tubes and thermistors, etc.

(ii) In p -region the direction of conventional current is same as flow of holes.

In n -region the direction of conventional current is opposite to the flow of electrons.



(iii) Forward bias resistance,

$$R_1 = \frac{\Delta V}{\Delta I} = \frac{0.8 - 0.7}{(20 - 10) \times 10^{-3}} = \frac{0.1}{10 \times 10^{-3}} = 10$$

$$\text{Reverse bias resistance, } R_2 = \frac{10}{1 \times 10^{-6}} = 10^7$$

Then, the ratio of forward to reverse bias resistance,

$$\frac{R_1}{R_2} = \frac{10}{10^7} = 10^{-6}$$

OR

In the given circuit, the junction diode is forward biased and offers zero resistance.

$$\therefore \text{The current, } I = \frac{3\text{V} - 1\text{V}}{200 \Omega} = \frac{2\text{V}}{200 \Omega} = 0.01 \text{ A}$$



The same THREE LETTERS will complete these three words.

Can you find the three-letter sequence?

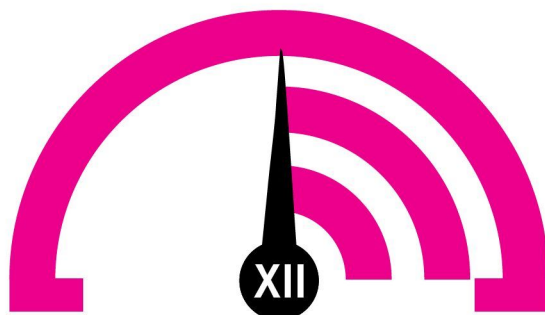
R O — — — I O N

G E O S — — — I O N A R Y

E L E C T R O S — — — I C S

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month. Winners' names will be published in next issue.

MONTHLY TEST DRIVE



This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

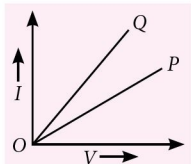
Time Taken : 60 Min.

Current Electricity

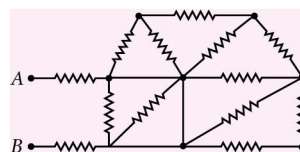
Total Marks : 120

NEET

Only One Option Correct Type

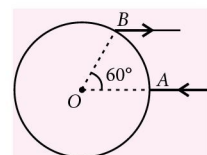
- The I - V graphs for two different electrical appliances P and Q are shown in the diagram. If R_P and R_Q be the resistances of the devices, then

 (a) $R_P = R_Q$ (b) $R_P > R_Q$
 (c) $R_P < R_Q$ (d) $R_P = \frac{R_Q}{2}$
- A uniform wire of length l and radius r has a resistance of $100\ \Omega$. It is recast into a wire of radius $\frac{r}{2}$. The resistance of new wire will be
 (a) $400\ \Omega$ (b) $100\ \Omega$ (c) $200\ \Omega$ (d) $1600\ \Omega$
- The electrical conductivity of a metal is
 (a) directly proportional to the mean free path
 (b) directly proportional to the mass of electron
 (c) inversely proportional to the relaxation time
 (d) inversely proportional to the mean free path
- A given resistor has the following colour code of the various strips on it : Brown, black, green and silver. The value of its resistance in ohm is
 (a) $1.0 \times 10^4 \pm 10\%$ (b) $1.0 \times 10^7 \pm 5\%$
 (c) $1.0 \times 10^6 \pm 10\%$ (d) $1.0 \times 10^5 \pm 5\%$
- A small town is located 10 km away from a power plant. An average of 120 kW of electric power is sent to this town. The transmission lines have a total resistance of $0.40\ \Omega$. Calculate the power loss, if the power is transmitted at 240 V.
 (a) 100 W (b) 10 W (c) 100 kW (d) 10 kW

- In the given circuit all resistances are of value R ohm each. The equivalent resistance between A and B is



- (a) $2R$ (b) $\frac{5R}{2}$ (c) $3R$ (d) $\frac{5R}{3}$

- A uniform wire of resistance 36 ohm is bent in the form of a circle. The effective resistance across the points A and B is



- (a) $5\ \Omega$ (b) $15\ \Omega$ (c) $7.2\ \Omega$ (d) $30\ \Omega$

- A wire of length 100 cm is connected to a cell of emf 2 V and negligible internal resistance. The resistance of the wire is $3\ \Omega$, the additional resistance required to produce a potential difference of 1 mV/cm on the wire is

- (a) $297\ \Omega$ (b) $60\ \Omega$ (c) $57\ \Omega$ (d) $35\ \Omega$

- Several lamps of 50 W and 100 V rating are available. How many of them can be connected in parallel across a battery of a 120 V of internal resistance $10\ \Omega$, so that all bulbs glow in full power?

- (a) 2 (b) 4 (c) 6 (d) 8

- Two unknown resistances are connected in two gaps of a meter-bridge. The null point is obtained at 40 cm from left end. A $30\ \Omega$ resistance is connected in series with the smaller of the two resistances, the null point shifts by 20 cm to the right end. The value of smaller resistance in Ω is

- (a) 12 (b) 24 (c) 36 (d) 48

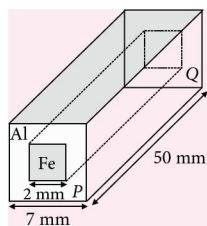
11. In a potentiometer experiment, the balancing point with a cell is at a length 240 cm. On shunting the cell with a resistance of $2\ \Omega$, the balancing length becomes 120 cm. The internal resistance of the cell is
(a) $1\ \Omega$ (b) $4\ \Omega$ (c) $0.5\ \Omega$ (d) $2\ \Omega$
12. In a potentiometer, a uniform potential gradient of $0.8\ \text{V m}^{-1}$ is maintained across its 10 m wire. The potential difference across two points on the wire located at 0 m 65 cm and 2 m 45 cm is
(a) 1.44 V (b) 0.144 V (c) 1.96 V (d) 0.196 V

JEE MAIN / JEE ADVANCED

Only One Option Correct Type

13. Two wires of resistances 4 ohm and 6 ohm have temperature coefficient of resistance $1.5 \times 10^{-3}/^\circ\text{C}$ and $3.0 \times 10^{-3}/^\circ\text{C}$ respectively. These are joined in series. The effective temperature coefficient of resistance is
(a) $1.4 \times 10^{-3}/^\circ\text{C}$ (b) $2.4 \times 10^{-3}/^\circ\text{C}$
(c) $3.4 \times 10^{-3}/^\circ\text{C}$ (d) $4.4 \times 10^{-3}/^\circ\text{C}$
14. The resistance of an electrical toaster has a temperature dependence given by $R(T) = R_0 [1 + \alpha(T - T_0)]$ in its range of operation. At $T_0 = 300\ \text{K}$, $R = 100\ \Omega$ and at $T = 500\ \text{K}$, $R = 120\ \Omega$. The toaster is connected to a voltage source at 200 V and its temperature is raised at a constant rate from 300 to 500 K in 30 s. The total work done in raising the temperature is
(a) $400 \ln \frac{5}{6}\ \text{J}$ (b) $200 \ln \frac{2}{3}\ \text{J}$
(c) $60000 \ln \frac{6}{5}\ \text{J}$ (d) $400 \ln \frac{1.5}{1.3}\ \text{J}$
15. The supply voltage to a room is 120 V. The resistance of the lead wires is $6\ \Omega$. A 60 W bulb is already switched on. What is the decrease of voltage across the bulb, when a 240 W heater is switched on in parallel to the bulb?
(a) 10.04 volt (b) zero volt
(c) 2.9 volt (d) 13.3 volt

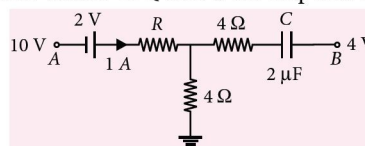
16. In an aluminium (Al) bar of square cross section, a square hole is drilled and is filled with iron (Fe) as shown in the figure. The electrical resistivities of Al and Fe are $2.7 \times 10^{-8}\ \Omega\text{m}$ and $1.0 \times 10^{-7}\ \Omega\text{m}$, respectively.



The electrical resistance between the two faces P and Q of the composite bar is

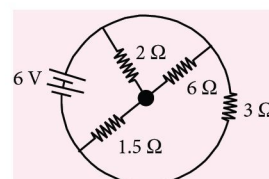
- (a) $\frac{2475}{64}\ \mu\Omega$ (b) $\frac{1875}{64}\ \mu\Omega$
(c) $\frac{1875}{49}\ \mu\Omega$ (d) $\frac{1875}{54}\ \mu\Omega$

17. A network of resistances, cell and capacitor $C (= 2\ \mu\text{F})$ is shown in figure. In steady state condition, the charge on $2\ \mu\text{F}$ capacitor is Q , while R is unknown resistance. Values of Q and R are respectively



- (a) $4\ \mu\text{C}$ and $10\ \Omega$ (b) $4\ \mu\text{C}$ and $4\ \Omega$
(c) $2\ \mu\text{C}$ and $2\ \Omega$ (d) $8\ \mu\text{C}$ and $4\ \Omega$

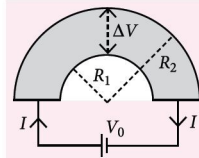
18. The total current supplied to the circuit by the battery is



- (a) 1 A
(b) 2 A
(c) 4 A
(d) 6 A.

More than One Option Correct Type

19. Shown in the figure is a semicircular metallic strip that has thickness t and resistivity ρ . Its inner radius is R_1 and outer radius is R_2 . If a voltage V_0 is applied between its two ends, a current I flows in it. In addition, it is observed that a transverse voltage ΔV develops between its inner and outer surfaces due to purely kinetic effects of moving electrons (ignore any role of the magnetic field due to the current). Then (figure is schematic and not drawn to scale)



TRIO

ANSWERS FEBRUARY 2023

The three letter word is Q U E.

TORQUE
FREQUENCY
BEQUEREL

Winners : Pooja Lunia, Evereen Tafannoom (West Bengal), Ayan Sharma (Jaipur), Tanishqa (Delhi), Sushanta Dhibar (West Bengal)

$$(a) I = \frac{V_0 t}{\pi \rho} \ln \left(\frac{R_2}{R_1} \right)$$

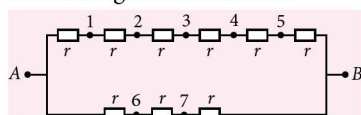
- (b) the outer surface is at a higher voltage than the inner surface
 (c) the outer surface is at a lower voltage than the inner surface
 (d) $\Delta V \propto I^2$

20. An incandescent bulb has a thin filament of tungsten that is heated to high temperature by passing an electric current. The hot filament emits black-body radiation. The filament is observed to break up at random locations after a sufficiently long time of operation due to non-uniform evaporation of tungsten from the filament. If the bulb is powered at constant voltage, which of the following statement(s) is (are) true?

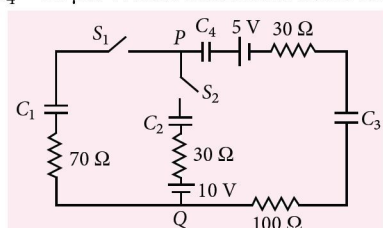
- (a) The temperature distribution over the filament is uniform.
 (b) The resistance over small sections of the filament decreases with time.
 (c) The filament emits more light at higher band of frequencies before it breaks up.
 (d) The filament consumes less electrical power towards the end of the life of the bulb.

21. In the circuit shown in the figure all the resistances are identical and each has the value $r \Omega$. The equivalent resistance of the combination between the points A and B will remain unchanged even when the following pairs of points marked in the figure are connected through a resistance R .

- (a) 2 and 6
 (b) 3 and 6
 (c) 4 and 7
 (d) 4 and 6



22. In the circuit shown, initially there is no charge on capacitors and keys S_1 and S_2 are open. The values of the capacitors are $C_1 = 10 \mu\text{F}$, $C_2 = 30 \mu\text{F}$, $C_3 = C_4 = 80 \mu\text{F}$. Which statements is/are correct?

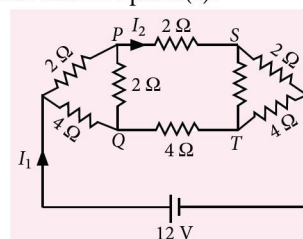


- (a) The key S_1 is kept closed for long time such that capacitors are fully charged. Now key S_2 is closed, at this time, the instantaneous current across

30Ω resistor (between points P and Q) will be 0.2 A (round off to 1st decimal place).

- (b) If key S_1 is kept closed for long time such that capacitors are fully charged, the voltage across capacitor C_1 will be 4 V.
 (c) At time $t=0$, the key S_1 is closed, the instantaneous current in the closed circuit will be 25 mA.
 (d) If S_1 is kept closed for long time such that capacitors are fully charged, the voltage difference between P and Q will be 10 V.

23. For the resistance network shown in the figure, choose the correct option(s).



Contributed by : Asmita Dam

SOLUTIONS TO FEBRUARY 2023 WORD GRID

S	D	F	R	E	Q	U	E	N	C	Y	V	S	I
O	E	L	A	S	T	O	M	E	R	S	I	D	U
L	M	U	X	E	R	O	X	I	D	B	S	R	N
E	O	R	V	I	F	K	Q	R	C	X	C	I	T
N	D	C	O	B	E	V	B	T	O	R	O	F	I
S	E	L	A	S	T	I	C	I	T	Y	S	T	M
O	T	L	G	B	B	S	T	R	C	A	I	D	E
L	I	N	E	A	R	M	O	M	E	N	T	U	M
E	N	X	I	L	L	O	S	R	N	C	Y	N	O
N	B	A	S	M	M	S	C	E	D	C	N	Y	S
O	U	Q	T	E	E	I	I	S	U	B	Q	K	C
I	L	D	C	R	R	T	L	I	C	S	U	S	I
D	P	X	S	Q	D	Y	L	S	T	I	M	E	L
R	A	D	I	O	A	C	T	I	V	I	T	Y	L
I	R	B	L	S	P	M	T	A	V	L	A	O	A
E	I	N	K	E	G	W	I	N	I	Y	C	L	T
C	N	Z	B	A	R	O	M	E	T	E	R	P	I
G	W	C	Y	K	N	R	N	C	Y	R	C	M	O
S	P	O	I	S	E	K	I	R	C	U	I	T	N

Across

- Elasticity
- Linear momentum
- Poise
- Radioactivity
- Barometer

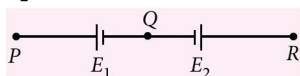
Down

- Viscosity
- Solenoid
- Balmer
- Work
- Oscillation

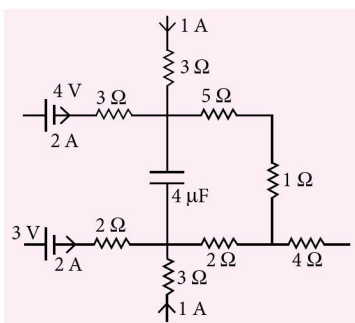
- (a) The current through PQ is zero.
 (b) $I_1 = 3 \text{ A}$.
 (c) The potential at S is less than that at Q .
 (d) $I_2 = 2 \text{ A}$.

Numerical Value Type

24. A resistor dissipates 192 J of energy in 1 s when a current of 4 A is passed through it. Now, when the current is doubled, the amount of thermal energy dissipated in 5 s is _____ J.
25. A battery of emf 8 V with internal resistance 0.5 Ω is being charged by a 120 V d.c. supply using a series resistance of 15.5 Ω . The terminal voltage of the battery is _____ V.
26. Consider the two cells having emf E_1 and E_2 ($E_1 > E_2$) connected as shown in the figure. A potentiometer is used to measure potential difference between P and Q , and the balancing length of the potentiometer wire is 0.8 m. Same potentiometer is then used to measure potential difference between P and R , and the balancing length is 0.2 m. Then what will be the ratio of E_1/E_2 ?



27. A part of circuit in a steady state along with the currents flowing in the branches, the values of resistances etc., is shown in the figure.



If the energy stored in the capacitor $C(4 \mu\text{F})$ is $n \times 10^{-4} \text{ J}$, then find the value of n .

Comprehension Type

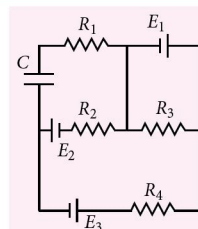
In the given circuit

$$E_1 = 3E_2 = 2E_3 = 6 \text{ volt}$$

$$R_1 = 2R_4 = 6 \text{ ohm}$$

$$R_3 = 2R_2 = 4 \text{ ohm}$$

$$C = 5 \mu\text{F}$$



28. The current in R_3 is

- (a) 2 A (b) 3 A (c) 1.5 A (d) 2.5 A

29. The energy stored in the capacitor is

- (a) $1.44 \times 10^{-5} \text{ J}$ (b) $2.39 \times 10^{-5} \text{ J}$
 (c) $1.44 \times 10^{-4} \text{ J}$ (d) $3.39 \times 10^{-2} \text{ J}$

Matrix Match Type

30. Match column I with column II.

Column I		Column II	
(A)	Electrical conductivity of conductor depends on	(p)	Dimension (length, area of cross section etc.)
(B)	Resistance of a conductor depends on	(q)	temperature
(C)	For a given conductor of given dimensions and at a given temperature, current density depends on	(r)	nature of conductor
(D)	For a given potential differences applied across a conductor of given dimension, current in it will depend on	(s)	electric field strength

- (a) (A) $\rightarrow$ (p, q); (B) $\rightarrow$ (q, r); (C) $\rightarrow$ (r, s); (D) $\rightarrow$ (p, r)
 (b) (A) $\rightarrow$ (q, r); (B) $\rightarrow$ (p, q, r); (C) $\rightarrow$ (s); (D) $\rightarrow$ (p, q, r)
 (c) (A) $\rightarrow$ (p, q, r); (B) $\rightarrow$ (p); (C) $\rightarrow$ (s); (D) $\rightarrow$ (q, r)
 (d) (A) $\rightarrow$ (p, q, r); (B) $\rightarrow$ (p, r); (C) $\rightarrow$ (q); (D) $\rightarrow$ (p, r)



Keys are published in this issue. Search now! ☺

SELF CHECK

No. of questions attempted

No. of questions correct

Marks scored in percentage

Check your score! If your score is

> 90% **EXCELLENT WORK !**

You are well prepared to take the challenge of final exam.

90-75% **GOOD WORK !**

You can score good in the final exam.

74-60% **SATISFACTORY !**

You need to score more next time

< 60% **NOT SATISFACTORY!**

Revise thoroughly and strengthen your concepts.

mtg

Add Little 'Extra' to your Knowledge
to Become 'Extraordinary'

INDIA'S
NO.1

MONTHLY MAGAZINE FOR

NEET | JEE | CUET | CBSE Boards

Get Crystal Clear Concepts and
Best of Practice Material Every Month



@75/- each
100 pages in each

SUBSCRIBE TO GET UP TO 64% DISCOUNT



Subscription Form

Yes! I wish to Subscribe 'MTG Magazine'.

Please tick your subscription scheme and send this form to **MTG Learning Media (P) Ltd.**,
Plot 99, Sector 44, Gurugram-122 003 (HR). Enclose Demand Draft favouring.

SELECT SUBSCRIPTION PLAN

Subject	Format	☐ 1 Year	☐ 2 Years	☐ 3 Years
Individual ☐ Physics ☐ Chemistry ☐ Mathematics ☐ Biology	☐ Print issue	900 ₹ 749/- (Save 17%)	1800 ₹ 1349/- (Save 25%)	2700 ₹ 1799/- (Save 33%)
	☐ Print + Digital	1000 ₹ 1150/- (Save 36%)	3600 ₹ 1850/- (Save 49%)	5400 ₹ 2400/- (Save 56%)
Combo of 3 Magazines ☐ Physics, Chemistry, Biology ☐ Physics, Chemistry, Mathematics	☐ Print issue	2700 ₹ 2200/- (Save 19%)	5400 ₹ 4000/- (Save 26%)	8100 ₹ 5400/- (Save 33%)
	☐ Print + Digital	5400 ₹ 3000/- (Save 44%)	10800 ₹ 5000/- (Save 54%)	16200 ₹ 6600/- (Save 59%)
Combo of 4 Magazines ☐ Physics, Chemistry, Mathematics, Biology	☐ Print issue	3600 ₹ 2800/- (Save 22%)	7200 ₹ 5200/- (Save 28%)	10800 ₹ 6300/- (Save 42%)
	☐ Print + Digital	7200 ₹ 3800/- (Save 47%)	14400 ₹ 6399/- (Save 56%)	21600 ₹ 7800/- (Save 64%)
Courier Charges Add to your subscription amount for quicker & traceable delivery		₹ 800/-	₹ 960/-	₹ 1440/-



Scan QR CODE or
visit this link
bit.ly_3VUBMH
**SUBSCRIBE MAGAZINE
ONLINE**

Note: Magazines are dispatched by Book-Post on 4th of every month (each magazine separately)

- ☐ Student
☐ Teacher
☐ Coaching
☐ School Library

Name: _____

Complete Postal Address: _____

Pin Code: _____

Mobile No.: _____ Email: _____

For more details about the offer, you may contact us:

0124-6601200

8800255335

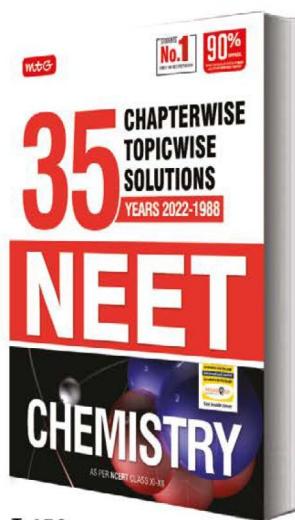
subscription@mtg.in

www.mtg.in

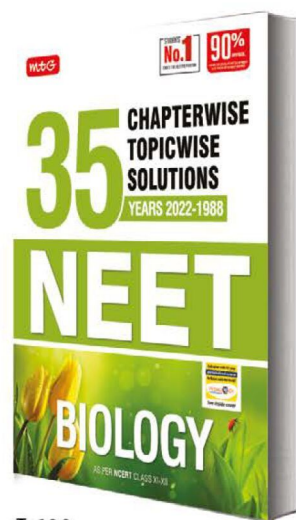
The most comprehensive **question bank books**
that you cannot afford to ignore



₹ 450



₹ 450



₹ 600

35 Years' NEET Chapterwise-Topicwise Solutions Physics, Chemistry & Biology contain not only Chapterwise-Topicwise questions that have appeared over the last 35 years in NEET, but also full solutions, that too by experts. Needless to say, these question banks are essential for any student to compete successfully in NEET.

HIGHLIGHTS:

- Chapterwise -Topicwise questions of last 35 years' (2022-1988) of NEET/AIPMT
- Chapterwise -Topicwise segregation of questions to help you assess the level of effort required to succeed
- An unmatched question bank series with close to 1,000 pages having detailed solutions by experts

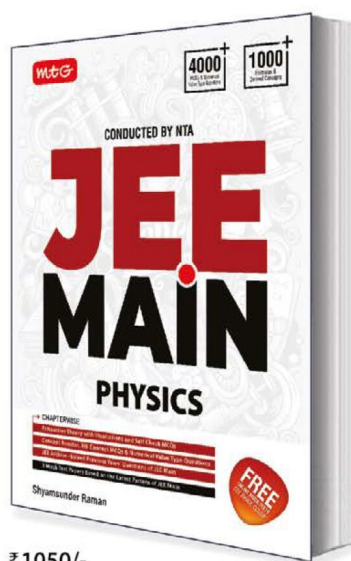


Scan to buy on mtg.in

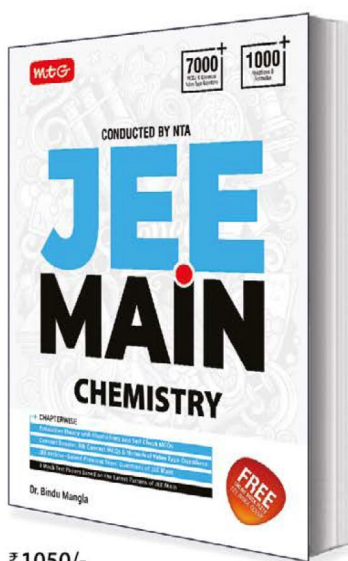
Study right. Dig deep.

mtg

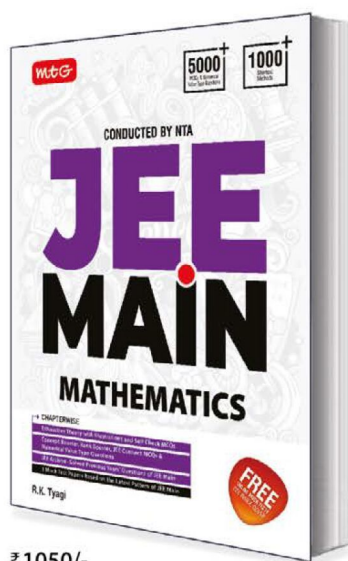
Build a solid foundation for success
in JEE Main



₹ 1050/-



₹ 1050/-



₹ 1050/-

Are you a do-it-yourself type of a student? Then for success in JEE Main, choose MTG's JEE Main combo, comprising coursebooks for Physics, Chemistry & Mathematics. This combo is all class XI and XII students need for a solid and deep understanding of concepts in these three key subjects.

FEATURES

- Based on latest pattern of JEE Main
- Covers the entire syllabus
- Full of graphic illustrations for deep understanding of concepts
- Exhaustive Theory with Illustrations and Self Check MCQs
- Chapterwise Concept Booster, Rank Booster and JEE Connect MCQs
- Chapterwise Numerical Value Type Questions
- JEE Archive-Solved Previous Years' Questions of JEE Main
- 3 Mock Test Papers based on Latest Pattern of JEE Main



Scan now with your
smartphone or tablet
Application to read
QR codes required

Note: Coursebooks are also available separately.

Available at all leading book shops throughout India. To buy online visit www.mtg.in.

For more information or for help in placing your order, call 0124-6601200 or e-mail: info@mtg.in

To be a NEET champion, you need help from a CHAMPION



Skill. Passion. Hard work and determination. As a student sitting for the highly competitive NEET, you need all that. However, only a few will win, very likely with the help of a champion coach.

MTG's NEET Champion Series is just the coach you need. It will guide you in identifying what's important for success and what's not. And then help you check your readiness with its most comprehensive question bank.

So you know your strengths and weaknesses right from the word go and course-correct accordingly. Put simply, MTG's NEET Champion Series will help you manage your preparation effort for NEET for maximum outcome. The best part is you study at a pace you're comfortable with. Because it's all chapterwise, topicwise.



₹850/-



₹850/-



₹900/-

HIGHLIGHTS

- NCERT-based • Chapterwise - Topicwise
- 10 years' (2022-2013) solved previous test papers (all major medical entrance exams)
- Concise summary at the start of each chapter for quick revision of key concepts
- Analysis of importance of topics basis historical examination pattern
- Test papers for self-assessment

Visit www.mtg.in to buy online.
Or visit a leading bookseller near you.
For more information,
Call 1800-10-38673
(toll-free) or 0124-6601200 today.
E-mail: info@mtg.in



Scan to buy on mtg.in

NEET
2018

More than
80%
same or
similar MCQs

NEET
2019

More than
80%
same or
similar MCQs

NEET
2020

More than
85%
same or
similar MCQs

NEET
2021

More than
90%
same or
similar MCQs

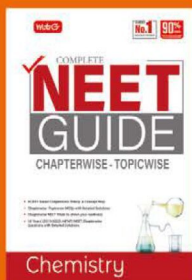
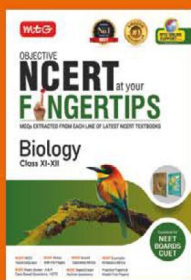
NEET
2022

More than
90%
same or
similar MCQs

Trust MTG for getting it right, year after year

Over the last 5 years, MTG has averaged a hit rate of 85% when it comes to curating the right content for your NEET preparation. Which means approx. 3.5 out of 4 questions in NEET were either exactly the same as, or similar to, questions in MTG's NEET books. The credit for this mind-blowing feat goes to MTG's skilled and experienced editorial team which painstakingly goes through volumes of NCERT subject matter that forms the basis for NEET, to create superior and relevant study material that has a high chance of success for its users. Proof lies in the pudding, right!

#1 Bestseller on Amazon



Scan to buy more
NEET Books on mtg.in

To find out which MTG NEET book is best-suited to your needs,
Call our NEET helpline **0124-6601200** today.
Or email info@mtg.in now. Visit bit.ly/mtg-neet to buy online.

mtg



Scan to buy on Amazon.in

EXCEL ACADAMICS®

Bengaluru

A Premier Institute in KARNATAKA

Integrated PUC | PUC+NEET | PUC+IIT-JEE | PUC+CET



FOR
CBSE 12th
17.03.2023
FRIDAY

FOR
2nd PUC
24.03.2023
FRIDAY

NEET / IIT-JEE / CET LONG TERM COURSE

PCB / PCM (Repeaters Course)

REGISTRATIONS STARTED FOR

NEET, IIT-JEE, K-CET

CRASH COURSE & LONG TERM (REPEATERS) 2023-24

Note : Registrations Started for
Integrated PUC + CET / NEET / IIT-JEE

NEET / CET/ IIT-JEE

#326, 3rd A-Cross, Opp. People's Tree Hospital, Sheshadripuram College Road, Yelahanka New Town, Bengaluru - 560 064, KARNATAKA



7676-91-7777, 95136 57041, 9535656277.

★★★ Postal Coaching For PUC + CET / NEET / IIT-JEE / AIIMS / JIPMER Contact 9036357499 ★★★



Separate Deluxe Hostel for Boys and Girls





Outstanding Results

JEE (MAIN) 2023

Session-1



100

Percentile
Overall



Dhruv Sanjay Jain

4 Year
Classroom

43 100
Percentilers
(Physics or Chemistry or Maths)

625 **2606**

99+ Percentilers 95+ Percentilers
(Including Classroom + Distance & Digital) & Counting

➤ Scan the code
to check all the results
& watch the stories
of toppers



➤ Subject-wise 100 Percentilers from Classroom Programs

 100 Percentile in Maths 99.99 Percentile Kamyak Channa 4 Year Classroom	 100 Percentile in Chemistry 99.99 Percentile Aakash D Reja 4 Year Classroom	 100 Percentile in Physics 99.99 Percentile Mozeel Vanwani 1 Year Classroom	 100 Percentile in Maths 99.99 Percentile Tanishq Mandhane 4 Year Classroom	 100 Percentile in Physics 99.99 Percentile Shivanshu Kumar 4 Year Classroom
 100 Percentile in Physics 99.99 Percentile Adit Jindal 4 Year Classroom	 100 Percentile in Physics 99.98 Percentile Anoop Singh 4 Year Classroom	 100 Percentile in Physics 99.98 Percentile Shreyansh Solanki 2 Year Classroom	 100 Percentile in Physics 99.98 Percentile Shiv Narang 4 Year Classroom	 100 Percentile in Maths 99.98 Percentile Md Sahil Akhtar 4 Year Classroom
 100 Percentile in Physics 99.98 Percentile Raktim Kundu 2 Year Classroom	 100 Percentile in Physics 99.95 Percentile Siddharth Miglani 2 Year Classroom	 100 Percentile in Physics 99.95 Percentile Hardik Goyal 2 Year Classroom	 100 Percentile in Physics 99.95 Percentile Utkarsh Gupta 2 Year Classroom	 100 Percentile in Physics 99.94 Percentile Gaurang Gupta 3 Year Classroom

and many more top performers across 300+ branches in India

Though every care has been taken to publish the result correctly, yet Aakash Educational Services Ltd. shall not be responsible for inadvertent error, if any.

Admissions Open

➤ NEET | JEE

Foundation (Class 8-10)

Get up to **90% Scholarship***
Appear for Instant Admission &
Scholarship Test. Register now for FREE
visit: iactst.aakash.ac.in or scan the code

Scan the code
to apply



➤ Crash Courses

for NEET / JEE 2023

Complete coverage of syllabus
Tests, Study Material & more
Hurry! Batches begin soon

Scan the code
to apply



*Terms & Conditions apply.

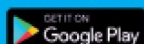


NEET Mock Test Paper
To Download,
Scan this QR Code



**JEE (Main & Advanced) & Other Engineering
Entrance Exams Mock Test Paper**
To Download,
Scan this QR Code

Download **Aakash App**



CALL (TOLL-FREE)
1800-102-2727

VISIT
aakash.ac.in

